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AGRICULTURAL EXPERIMENT STATION.

REPORTS OF EXPERIMENTS
ON
METHODS OF FERMENTATION
AND RELATED SUBJECTS
DURING THE YEARS 1886-87.

By E. W. HILGARD,
Professor of Agriculture and Director of the Station.

ADVANCE SHEETS FROM THE ANNUAL REPORT OF 1888.

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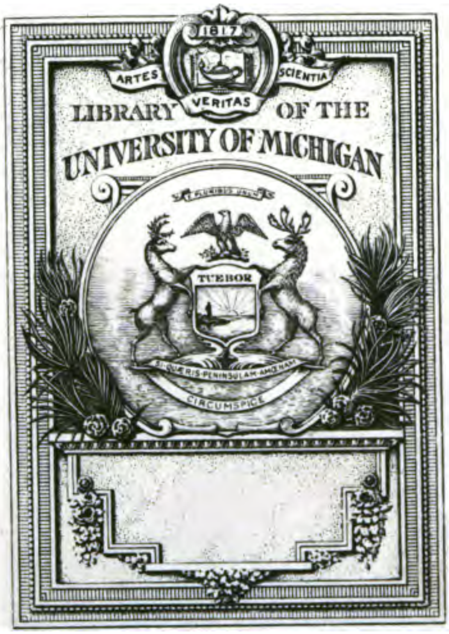
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INTRODUCTORY NOTE.

The time usually devoted by me to the writing of the annual reports having been, of necessity, given this season to the task of establishing the several outlying Culture Experiment Stations, it has been impossible to prepare for publication, in time for the vintage, the entire record of last season's viticultural work. I have, therefore, extracted from the mass of material, for advanced publication, such portions as it seemed most desirable to place at once before the viticulturists of the State; to wit, the results bearing most directly upon winery work; that, if properly utilized, will be found to remove from the latter a great deal of the difficulty and mystery with which, through the ignoring of principles well established by the experience of the Old World, it has heretofore been surrounded.

E. W. Hilgard.

Mission San José, *July*, 1888.

EXPERIMENTS ON VARIOUS METHODS OF FERMENTING RED WINES.

It is hardly necessary to insist on the importance of determining accurately the influence exerted by the varied conditions under which the fermentation of wines may be conducted, upon their ultimate quality. However important may be the influence of the original grape upon the wine produced, that wine may be essentially made or marred in the making; and no process or period in the manufacture of wine is of such fundamental importance as that of the first fermentation. Whatever faults have been committed at that time can be but very imperfectly, if at all, remedied in the after-treatment; and by far the greatest portion of all the "doctoring" practiced, whether in this State or elsewhere, is due to avoidable faults in the first fermentation.

Considering this fact, and that it is and long has been fully understood by wine experts, it is very remarkable that so few systematic investigations of the exact effects of different methods of conducting the first fermentation in practice, have been made. The proverbial difficulty of making agriculturists adopt changes in the old-time methods, no matter how salutary and necessary, accounts for this state of things; which has not been fully appreciated even by the viticultural experiment stations of Europe. For although theoretically the influence of the several factors may be fairly well understood, we vainly seek in their records any reasonably complete series of practical experiments in the premises. The various modes of conducting wine fermentation in different countries or regions are mentioned and commented upon as to their probable effects; but few actual tests for controlling the conclusions have been recorded.

Inasmuch as the practice of wine-making in California is still in the formative stage, it is to be hoped that a timely investigation and demonstration of the respective merits of the several systems may serve to prevent the definitive formation of bad habits, and thus save a great deal of disappointment and loss to wine-makers. This is so much the more important, as the peculiarities not only of different grape varieties, but of the same varieties grown in the widely varied climatic regions of the State, render differences in the mode of treatment in vinification indispensable.

EXPERIMENTS OF 1886.

A series of nine fermentations of second-crop Zinfandel grapes was made during the vintage season of 1886, and the results of these, with the preliminary conclusions to which they led, are recorded in the published report for that year. The second-crop grapes were used not as a matter of choice but of necessity, because no other grapes remained available at the time when the limited laboratory space allowed of entering upon the work, after the brunt of the vintage was over. This series of 1886 was, therefore, defective in that the material treated was not that from which the best wines are made; it being, moreover, one that (having low sugar and high acid) is noted for the ease and soundness of its fermentation. The results could therefore find only a limited application to those cases in which difficulties are usually experienced; namely, those of musts with high sugar contents and low acid, and from varieties that are liable to sluggish fermentation.

The following extract from the record of 1886 shows the nature of the experiments then made:

> The grapes used were a very good article of second-crop Zinfandel, courteously donated by Mr. J. Gallegos, of Mission San José. About one and one sixth tons were sent, in University basket crates. They arrived in excellent condition; the berries were rather small and the bunches quite loose, but thoroughly sound; taste agreeably sweet, and juice abundant. The composition of the latter was as follows:
>
> | | |
> |---|---|
> | Solid contents by spindle | 21.05 |
> | Sugar by copper test | 19.75 |
> | Acid | .65 |
> | Ash | .27 |
>
> Nine different samples were fermented, under the following conditions:
>
> (A.) In a hot chamber kept at a temperature ranging from 68° to 102°, two batches of about 63 pounds each; one (No. 557) left entirely open in the tub; the other (No. 556) covered with a "floating top" that rose and fell with the pomace, screening it from access of air. Both were subjected to "foulage" or stirring.
>
> (B.) In a room kept at a temperature ranging from 72° to 75°; five 50-gallon tanks, each charged with about 230 pounds, nearly filling the tanks, and arranged as follows:
>
> No. 558. Mash put in in three successive portions, kept separate by a lattice framework wedged in place, thus forcibly keeping the pomace submerged and divided into three separate portions—according to Perret's system; the uppermost frame being about two inches below the surface of the must before fermentation. Tank covered.
>
> No. 559. Mash put in at once and the pomace kept submerged about two inches by means of a single Perret's frame, as practiced to some extent at Fresno and elsewhere; no cover.
>
> No. 560. Mash left uncovered and subjected to frequent "foulage" or stirring, at least three times a day, during fermentation; a common French and also California practice.
>
> No. 561. Mash covered with a "floating cover," rising and falling with the pomace, any froth on upper side being washed of; stirred three times a day; a French method, and adopted at the Viticultural Laboratory.
>
> No. 563. Grapes put in whole, stems and all, to be gradually crushed by means of a cross-peg stirrer, used energetically three times a day; no cover. A Burgundy and Italian method, used at several California wineries; known as "Morel process."
>
> No. 564. A tub charged with about 140 pounds of mash, and then left to itself, cap, vinegar-flies, and all; without stirring or cover; the old Californian, or "go-as-you-please," method.
>
> (C.) In the cellar of the laboratory kept at a steady temperature of 62°.
>
> No. 562. Fifty-gallon tank charged like the rest with 230 pounds of grape mash, provided with "floating cover," and stirred three times daily.

The general results of these experiments may be thus summarized:

1. As regards the *duration* of the fermentation, it was found that the high temperature, ranging from 95° to 102°, *accelerated* the fermentation to an extraordinary degree, so that one tank (No. 556) actually went dry in about forty-eight hours. The tanks kept in a steady outside temperature of about 75°, went dry in from five to seven days; the one kept the cellar at 62°, took about ten days.

2. The *body* (fixed extract) of the wines was markedly increased in the hot fermentations. The nature of this increase remains to be ascertained.

3. As regards *alcoholic contents*, they were practically identical, and corresponded to the saccharine strength of the must, in six out of the nine tanks; while Nos. 559, 563, and 564, corresponding respectively to the single-frame, Morel, and "old-style" processes, show a deficiency which does not differ widely for the three, being not quite one per cent.

4. As regards *acid*, the two in which the greatest exposure to air occurred (the open foulage, No. 560, and No. 563, the "Morel" process) gave the highest results; the lowest were given by Nos. 556 and 558, the hot fermentation with cover, and by the one with the three submerged frames. These differences occurred in the absence of any notable proportion of acetic acid in any of the wines.

5. The maximum extraction of *tannin* occurred in the *two* hot fermentations, in which, despite of their short duration (two days) as much tannin was extracted as in the "Morel" process, stems and all, during *eleven* days: thus suggesting hot fermentations as at least one of the causes of the high tannin contents observed in wines from Fresno and other southern locations. The *smallest* amounts of tannin were found in the case of Nos. 558, 559 and 560, the two former being those in which no stirring was practiced on account of the use of stationary latticed frames, the third the one receiving the largest amount of aeration; the conclusion being that in one case the excess of oxygen, in the two others the lack of stirring, caused the deficiency.

6. As regards intensity of *color*, the deepest tints were obtained, Nos. 561 and 563, being respectively the tank with floating cover, and the "Morel" process. The two lowest were (as in the case of tannin) from the tanks in which the latticed frames were used, and therefore no stirring was practiced; while the next lowest was the one fermented at the low temperature of 62°, notwithstanding that in the latter case, diligent stirring was done, and the wine remained longest on the skins.

It should be remembered that all these data refer to the condition of things immediately after pressing. Soon after, it became apparent that the gain in color in some cases was not a permanent one, and that it faded most rapidly in the wines produced by hot fermentation; while among those fermented in an outside temperature of 75°, the one produced by the method adopted for vinification in the University laboratory—with floating cover—retained in the sixth month the *deepest* tint of all. The *lightest* tint of all was then shown by the wine No. 558, made by the use of three latticed frames, without stirring; the next lowest being that in which a single frame was used, and no stirring was done.

At the end of 20 months, we find the color in all greatly faded, as is usual in wines of low alcoholic contents. The *lowest* figures are still shown by the same samples; the *highest* are now shown in the hot-fermented ones, although, to the unaided eye, the difference (of two points) is imperceptible. The tints all have now passed from the "purple-reds" to the reds proper of the color scale. The subjoined table shows these facts at a glance; it proves (so far as single series of trials can prove anything) that practically the only permanent gain in the hot fermentation was in tannin, and that quite slight as compared with two others; at five months age the average of their color (16 per cent) falls below five others of the series.

TABLE 1. COMPOSITION OF WINES BY DIFFERENT MODES OF FERMENTATION. 1886.

Numbers	MODE OF FERMENTATION.		WINE.														
			Body.	Alcohol by Volume.		Acid, as Tartaric.		Tannin.	Color.								
									Nov., '86.		Dec., '86.		April, '87.		June, '88.	
			May, '87.	Nov., '86.	May, '87.	Nov., '86.	May, '87.	Nov., '86.	Int.	Tint.	Int.	Tint.	Int.	Tint.	Int.	Tint.
556	Foulage, with floating cover	Temp. 96°–100°.	3.0	9.73	8.77	.49	.50	.14	45.4	2 v. r.	36.3	2 v. r.	17.0	4 v. r.	10.1	1 r.
557	Foulage, without cover		3.1	9.73	9.54	.59	.58	.13	42.4	2 v. r.	31.8	4 v. r.	14.0	5 v. r.	10.4	3 r.
558	Three Perret's frame	Temperature, 72°–75°.	2.7	9.73	9.54	.49	.47	.10	30.0	2 v. r.	18.8	4 v. r.	7.4	2 r.	5.0	4 r.
559	Single Perret frame		2.7	9.00	8.70	.51	.47	.10	27.8	2 v. r.	18.0	3 v. r.	9.0	1 r.	5.6	4 r.
560	Foulage, no cover		2.6	9.73	9.73	.65	.65	.10	46.4	2 v. r.	35.7	2 v. r.	18.0	4 v. r.	6.6	2 r.
561	Foulage, with floating top		2.6	9.70	9.70	.55	.56	.12	47.0	2 v. r.	27.0	4 v. r.	20.6	3 v. r.	8.0	1 r.
563	"Morel process"		2.7	8.85	8.85	.51	.51	.13	47.6	2 v. r.	26.0	2 v. r.	17.7	5 v. r.	8.0	1–2 r.
564	Old style, no cover or foulage		2.7	9.90	9.63	.56	.58	.12	46.6	2 v. r.	30.0	3 v. r.	17.0	4 v. r.	8.2	1 r.
562	Foulage and floating top, temperature 62°		2.8	9.73	9.63	.56	.55	.12	34.1	3 v. r.	30.0	3 v. r.	17.0	4 r.	5.4	3 r.

The lessons conveyed by the above table might be briefly summarized thus: High temperature favors the formation of a heavy body. Loss of alcohol is distinctly shown in the cases of the "Morel" process, and in the use of the single latticed frame placed near the surface of the mash. The high-temperature fermentations have not only been very rapid, but have favored in a marked degree the complete extraction of color and tannin; but the gain in color has been only temporary, and later the relation has even been reversed. A slight loss of color and tannin seems to result from excessive aeration.

It should be added as regards the *quality* of the wines produced, that by the common consensus of all tasting them during the first year, numbers 558, 561 and 562 were awarded the preference; the hot-fermented samples being objected to as flat and without character, although having in some respects the appearance of greater maturity. The latter point is in agreement with the well-known effects of pasteurization in the same direction.

COMPARATIVE FERMENTATIONS MADE IN 1887.

In order to verify the results and conclusions deducible from the fermentations of 1886, they were repeated in 1887, but with a material corresponding more nearly to those which practically interest the wine-maker, and with three additional variations in the methods. In order, moreover, to set at rest all doubt as to the cogency of the main results so far as they apply to the Zinfandel must, two fermentations of the latter (almost identical in composition with that of 1886) were also made.

The grape most available for the purpose, because maturing late enough to be out of the way of the bulk of the vintage work, was the Carignane; of which grape a fine lot of 2,290 pounds was liberally presented by Mr. A. J. Salazar, of Mission San José. These grapes arrived November 1, having been picked the day before and packed in basket crates sent on for the purpose; and were crushed as soon after arrival as possible. They were in excellent condition for the season, in which on account of *coulure* in various stages, few varieties yielded perfect bunches. The berries were full ripe, a few overripe and flabby; a few dried unripe; a few bunches had unsound berries from having rested on the ground. The stems were green almost throughout; a few partly dried or rather, wilted. The unsound bunches and berries were picked out as closely as possible; and the outcome should make a very fair test of its kind.

The average percentage of the stems was 5.0 per cent of the gross weight. The average of pomace, after pressing, was 10.5 per cent, ranging from 9.8 to 11.75, according to the mode of fermentation; the average yield of murk (young wine), on pressing, was at the rate of 154.3 gallons per ton, ranging from 141.0 to 163.0, according to mode of fermentation. The details on these points are given farther on; but it will be noted that the differences in the yield of wine (arising from a more or less thorough disintegration of the grape pulp, as well as evaporation during the process) are so considerable as to deserve the attention of the wine-maker.

The composition of the juice at crushing was 25.75 solid contents by spindle, and .53 of acid, calculated as tartaric. It was therefore very fairly representative of the stronger class of musts of a California vintage, and, unlike the second-crop Zinfandel, not of a kind noted for easy and regular fermentation.

These grapes were divided into eleven lots, of which eight, intended to be fermented at a room temperature of 75°, were of 200 pounds each; two, intended to test the effect of high temperature in causing "arrested" fermentation, were made as large as the tanks would allow, viz., 230 pounds each, so that the greater mass might tend to a high degree of heat. One lot of 230 pounds was treated at 62° outside temperature.

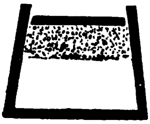
Of the nine modes of treatment adopted in 1886, eight were repeated; the one omitted being the "go-as-you-please" mode, in which the pomace cap was not stirred at all during fermentation, but was allowed to sour and become stocked with maggots. It seemed hardly worth while to spend time and work upon the test of a mode of procedure which must be set aside upon the most elementary principles of common sense. Instead, there were added three other variations, to wit: 1, the use of a single latticed frame that kept the pomace submerged too near the bottom of the tank; 2, a similar frame placed near the surface, the wine being pumped over from below several times a day; and finally, a tank left without cover, but stirred several times a day during the first three days, by pumping air into the bottom of the charge. These experiments, with five others, were made at the medium vintage air-temperature of 75° Fahr. Two were made in a chamber kept at about 90°, and one in a cellar where the air was steady at 62°.

Below is given a numbered list of the several experiments, with figures intended to present more clearly to the mind of the reader the exact arrangement and mode of treatment.

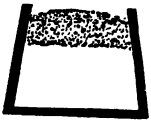
It must be remembered that in these experiments the object was not to produce the best possible wine from the given material; but to carry to their extreme consequences the several modes of procedure, in order to obtain unequivocal and unmixed indications of their characteristic effects upon the product of each.

DESCRIPTIVE LIST OF EXPERIMENTAL FERMENTATIONS—1887.

CARIGNANE GRAPES.—A. *In a chamber kept at from 90° to 95°;*



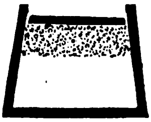
No. 795. 230 pounds of grape mash, covered with a floating cover, and stirred thrice daily.



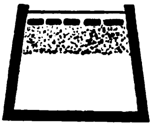
No. 797. Same charge, but no floating cover; stirred thrice daily.

(Both of the above numbers were subsequently subdivided for different after-treatments, into parts numbered 795*a*, 797*b* and 797*c*, as indicated in the table below):

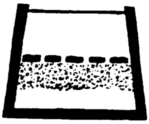
B. *In a room kept at from 72° to 75°.*



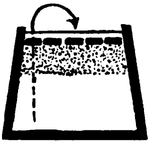
No. 787. 200 pounds of grape mash, with floating cover; stirred thrice daily; the mode of fermentation adopted for general use in the Viticultural Laboratory.



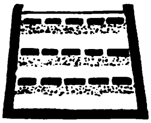
No. 788. Same charge, with a single latticed frame fixed near the surface of the mash; no stirring.



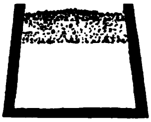
No. 789. Same charge, with a latticed frame fixed half way down, so as to keep the pomace cap within a few inches of the bottom of the tank.



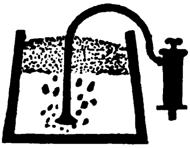
No. 790. Same charge, with latticed frame held near the surface of the mash; the wine pumped over from below, over the surface, for ten minutes, twice daily.



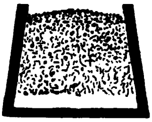
No. 791. Same charge, divided into three portions, each held down separately by a latticed frame, so as to divide the pomace into three portions during fermentation. Perret's method.



No. 792. Same charge, uncovered; stirred thrice daily.

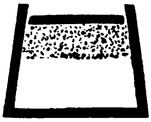


No. 793. Same charge, uncovered; stirred thrice daily during the first three days, by pumping air through for ten minutes; afterwards stirred by hand only.



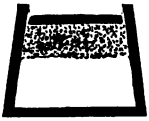
No. 794. 200 pounds of grapes put in the tank unstemmed, and crushed gradually by means of a cross-peg stirrer used thrice daily; no cover. "Morel" process.

C. *In a cellar kept steadily at 62°.*

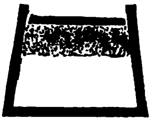


No. 796. 230 pounds of grape mash, with floating cover, stirred thrice daily.

A second series of fermentations was made with *third-crop Zinfandel* grapes (donated by Mr. Juan Gallegos), for the express purpose of verifying the observations of last year in regard to the influence of high temperature in rushing through the fermentation of weak musts; the arrangement being as follows:



No. 800. 565 pounds of grape mash, with floating cover, in chamber kept at from 90° to 95°; stirred thrice daily.



No. 799. Same charge, and same method as preceding, but in a temperature of 72° to 75°.

Throughout the course of these fermentations, the progress of color-extraction was closely watched, samples being taken daily, and in the case of the second set, every few hours. The progress of the formation of alcohol was also noted on the same samples.

THE COURSE OF FERMENTATION.

The following table shows the course of fermentation in the fifteen experiments made, three of these being continuations of experiments first started with two tanks at high temperatures. The last two columns show the two fermentations of 3d crop Zinfandel, made to check the results of 1886.

The figures on the right indicate observed temperatures. Of two, the upper one shows the maximum observed in the pomace, usually within an inch of the lower surface of the cap; the lower, the temperature of the wine beneath the cap. A third figure below sometimes shows the temperature of the bottom of the tank.

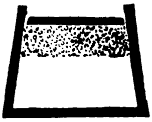
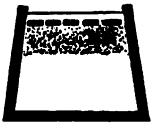
In the case of No. 791, each of the three figures shows the temperature of the pomace and wine beneath the corresponding one of the three frames.

It will be noted that in every case the maximum in the cap is higher than in the liquid beneath, and often occurs earlier than in the case of the latter.

Starting of the Fermentation.—In regard to this point, the observations of the "second day" show that among the Carignane tanks subject to the external temperature of 75°, and set at 63°, those receiving the greatest amount of aeration started soonest; viz., Nos. 792 and 793. In fact, they started as quickly as those set originally at 86°, but the latter set up a rapid action somewhat sooner. This fact—the quickening of the beginning of fermentation by the influence of aeration—is well understood in Europe, and is often provided for by special appliances in the making of both red and white wines. The greater regularity of the whole process, its earlier completion, and the quicker clearing of the young wine, are additional advantages known to result from the aeration of the must or mash.

It will be noted that although the mash of Nos. 795 and 797 was set at 86°, yet the action was so little favored by the high temperature in this case that the latter fell to 65° during the night, and the heating had to be repeated. This fact stands in striking contrast to the behavior of the Zinfandel must in the series of 1886 as well as 1887, in which the action began so promptly that the original temperature scarcely had time to decline materially.

Maximum Temperature.—The record shows that the maximum temperature of the wine below the cap was reached on the afternoon of the 4th day after setting, by five out of the eight tanks under the influence of

	No. 787. Floating Cover.	No. 788. Single Frame, Top.	Singl
			
First day	2:30 P. M. .... 63°.	3:30 P. M. .... 63°.	4:30 P.
Second day	9 A. M. .... 65°. 5:30 P. M. .... 71°.	9 A. M. .... 65.5°. 5:30 P. M. .... 67°.	9 A. M. 5:30
Third day	8:30 A. M. .... 70°. 10:30 A. M. .... 72°. Slight cap; frothing. 4 P. M. .... 74°. 73°. 9 P. M. .... 78°. 77°.	8:30 P. M. .... 70°. 67°. 10 A. M. .... 70°. Action starting. 4 P. M. .... 69°. Going very slowly. 9 P. M. .... 74°. 71.5°.	8: 10 4 P. 9 P.
Fourth day	9 A. M. .... 96°. 93°. Cap dry; violent action below. 2 P. M. .... 98°. 95°. 3 P. M. .... 94°.	9 A. M. .... 81°. 79°. 75°. Ferm'n going rapidly. 3 P. M. .... 87°. 86°. 80°.	9 A. M

an outside temperature of 75°; the first one to reach that point being No. 786 (the *"normal" tank), at 96°, in 72.5 hours. Next after it came No. 789 (the one having the latticed frame halfway down in the mash), in 76.5 hours, reaching 94°; and in striking contrast to this stands No. 788, in which the latticed frame was placed near the upper surface, and which took nineteen hours longer (95.5) to reach its highest temperature, and nearly twice the length of time to attain substantial dryness; the maximum reached, however, was 88.5° only. In No. 780 (also with frame near the surface), it is apparent that the aeration given in pumping the wine over from beneath the cap hastened the whole process materially as compared with No. 788, especially in that the maximum (92.5°) was reached in the cap as early as in the case of the depressed frame (No. 789); but in the wine itself there was a delay of twelve hours thereafter.

In the case of the tank with three frames (No. 791, Perret's process), the maximum (89 to 91°) was of course reached at different times beneath each of the three caps, traveling from above downward; showing a time of 77 hours under the uppermost frame, and 83 under the two lower ones. Doubtless the maximum would have occurred later under the lowest one, as was the case last year, but for the tendency of the pomace to rise up past the outer edge of the frame, thus mixing the layers. The maximum reached at *any* time was 91°, showing conclusively (in accord with last year's observations), that this mode of treatment may be advantageously employed to prevent an excessive rise of temperature.

Nos. 792 and 793—both left uncovered, but stirred, one in the usual manner and the other by pumping air—reached the maximum in the wine about simultaneously, in 81 hours; but the attainment of the maximum six hours earlier in the caps, in the case of air-stirring, the higher temperature reached (95° against 93°) and the earlier completion of active fermentation by nearly two days, accentuates strongly the favoring influence of thorough aeration.

In the case of the "Morel" process, expressly designed to delay fermentation and maintain a low temperature, the long delay of 103 hours is of course natural, and is pretty much within the power of the operator to regulate. It is quite certain, however, that unless this prolongation of fermentation is accompanied by proper precautions against the acetification (use of cover or latticed frame), unsoundness is exceedingly apt to come about. In the case in hand the maximum reached (93°) was after all not lower than in Nos. 796, 791 and 792, either of which would seem to be safer processes for the soundness of the wine.

No. 796, kept under the influence of an outside temperature of 62°, reached its maximum of only 85° after 101 hours, the conditions being otherwise the same as those under which No. 787 rose to 95° in 72 hours. Yet the cessation of action was not nearly as long delayed as in the case of No. 788 (single frame near surface without stirring, at 75°); and the result was certainly a much better wine.

THE HOT FERMENTATIONS.—The two hot fermentations (Nos. 795 and 797), under the influence of an outside temperature of 90° to 95°, reached the same maximum of 105°, 42 hours after setting. Here, as in the cooler tanks, the use of the floating cover is attended with quicker progress. It will be noted that on the sixth day the solid contents of the wine No. 795 had diminished down to 12.25 per cent, while in the open tank the spindle

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[*] So called for convenience sake, being the mode usually adopted for red wines in the University Laboratory, viz.: floating cover and storage.

still showed 13.0. *At this time most of the other tanks were approaching dryness.*

What is especially worthy of note in this connection is the narrow limit that separates the temperatures at which the fermentation is accelerated, and that at which it is almost totally stopped by the paralysis, or death, of the active yeast. In the case of No. 787 (floating cover, 75°), the maximum of 95° was maintained for about nine hours, during which the fermentation was very active as yet. In the tank No. 795, temperatures of 100° and over were maintained for about 24 hours, and the violent activity shown at first very rapidly slowed down; on the morning of the 4th day it had become extremely slow. As the temperature fell it gradually revived a little, but it soon became apparent that it would not "go dry" under present conditions; and it was divided into two parts, in order to test the means of reviving the action, one portion being, however, kept in the hot chamber, in order to carry the process to its ultimate conclusion. That conclusion was, that after continuing a slow action up to the 15th day, the cap sank and the tank was as "dead stuck" as could have been desired; while the solid contents were still at 9.5 per cent, of which 5.78 per cent was unfermented sugar. By this time milksourness, as well as acetification, was very pronounced to the taste; and as manifestly nothing more than these would be the result of continuing the experiment as it was, the wine was drawn off into glass and bunged moderately tight, so as to allow of escape of gas.

The subsequent history of this sample is worthy of mention and may as well be recorded here. Ten days after drawing off it was noted that the bung had been thrown out, and on examination it was found that fermentation, or at least the lively giving off of gas had recommenced. The solid contents were at that time found to be 8.3 per cent, showing that a part of the sugar had fermented out since drawing off. The giving off of gas continued steadily for nearly a month, when the spindle showed about 7 per cent of solid contents, and the intensely acid wine was found with 1.47 of acid (calculated as tartaric); alcohol 9.73 per cent. The sample was then racked, and in June, 1888, it shows only 1.27 of acid and 9.27 of alcohol, the acid and alcohol having evidently combined to form a compound ether. Of course it is an undrinkable, vicious-tasting compound; but yet only an exaggeration of the wines occasionally offered for sale by innocent producers, particularly from the warm districts of the State.

The exact nature of the after-fermentation just referred to is not clear, and want of time has prevented an examination of its product except to the extent of determining that of the 1.26 per cent of acid now in the wine, .57 is volatile. But this volatile acid is clearly only in part acetic, as might also be inferred from the nature of the fermentation; since acetification is not accompanied by the evolution of either carbonic or any other gas, and could not have occurred in a closed vessel. At the present time (June, 1888,) the solid contents amount to 6.3 per cent, including 5 per cent of sugar.

Revival of the Fermentation in the Hot Fermented Mashes.—As already stated, the fermentation of the hot fermented samples began to revive so soon as the temperature was lowered down to 80° or less; but it remained sluggish, and evidently if left to itself would not carry the wine through. In order to test various methods of reviving the action, three of the four parts into which tanks 795 and 797 had been divided, were treated respectively as follows:

No. 795*a*, a part of tank 795, was placed in the fermenting room kept at 75°; a floating cover was put on it to forestall farther acetification, and it was then treated like No. 793, by pumping air through it thrice daily for three days, afterwards simply using "foulage" as usual. The fermentation revived slowly, but without at first forming a well defined cap; at the end of 48 hours, however, a good cap was present; and at the end of the third day after removal from the hot chamber, the solid contents had diminished from 11.5 to 10.8. Action having now been fairly reëstablished by simple aeration and lowering of the temperature, the mash was once more warmed to 80° by means of a can filled with warm water; the action thereafter was sufficient to maintain the warmth unaided, and the fermentation progressed normally until, on the seventh day after the change was made, the solid contents had fallen to 4.4 per cent, with only .76 of sugar, and the tank charge was sent to the press. At that time the solid contents of No. 795 (the portion remaining in the hot chamber) were within a fraction of 10 per cent.

It is hardly necessary to comment upon the lesson conveyed in this experiment, as to measures to be taken to revive the action in a "stuck" tank. But in practice the wine-maker should never wait until the evil reaches the extreme phase at which in this case the change was made; when acetification and a slight taint of milksourness had already developed. Had tank No. 795 been cooled down on the fourth day by means of vigorous aeration and, perhaps, direct cooling down to 80° by means of a cold water coil, it would doubtless have remained sound and have gone through without trouble, and without the use of either yeast or fresh must.

When, however, the latter is available, there is no reason why the revival of action should not be made doubly sure, by its use after first starting it into vigorous fermentation. More than this, there is no reason why sound pomace, whether pressed or taken from the (sound) cap of another tank, should not be similarly used. Both methods were tested on the two portions of the tank No. 797.

To No. 797*b* (8 gallons) was added a pound of freshly pressed pomace from No. 789, and ordinary stirring given; outside temperature 75°. The action quickly revived but did not progress as rapidly as that of No. 795*a*, and the pressing was done thirty hours later, with over 1 per cent of sugar remaining in the wine.

No. 797*a* (18.5 gallons) was mixed with 2.5 gallons of fresh must made up from the "condensed" article supplied from the Geyserville factory, by dilution with water to the same density as that originally shown by the Carignane must; this must was allowed to go into active fermentation (of its own accord) before mixing it with the other mash, the spindle showing 13.5 in the mixture. Action soon began, but like the others, it needed a little help at first by warming up; but afterward the warmth was maintained without aid and the mash was ready for the press about the same time as 797*b*, but not as early as the sample 795*a*, which had the benefit of thorough aeration by pumping.

Comment on the above record is hardly necessary, but its teachings may be summed up thus: *Aeration alone may, in mild cases of arrested fermentation, serve to revive it*, aided, if the tank has cooled down, by *warming up to say 80°*. But as the arrest is due to paralysis or death of the yeast cells, through excessive heat, it is desirable always to favor the re-formation of the active yeast by the *addition either of sound pomace, or of fermenting must from other tanks*, or specially prepared for the purpose.

As these means are or should be available in almost every winery, the use of artificial yeast, especially of that prepared from floury materials, is usually as unnecessary as it is dangerous to the keeping qualities of the wines.

THE ZINFANDEL FERMENTATIONS.—The salient point in both of the fermentations made with 3d crop Zinfandel, is their very short duration as compared with the Carignane under similar conditions, alike of high and of low temperature. In No. 799, we have 72 hours against 138 required for the corresponding number (787) in the case of the Carignane, both treated at a low temperature (75.0°); while No. 800, under the influence of a warm chamber, flashed off in *48 hours*, as was the case in 1886, although its temperature rose to 99°, against 83° only in the case of the cooler tank. The corresponding tank with the Carignane was "dead" after *15 days*, with nearly 6 per cent of sugar left unfermented.

It is hardly necessary to recall to mind that these marked differences stand in no direct proportion to the original difference in the saccharine strength of the respective musts; for this amounted to only 4 per cent of sugar. It may be said that the divergence might be attributable to the intrinsic character of the grapes as well as to the difference in sugar contents. It is quite likely that such a *specific* difference actually exists and has influenced the result; but it cannot be doubted that in the main, the marked discrepancies noted between the course of the respective fermentations are due to the greater saccharine strength of one must as compared to the other. Direct experiments to test this point are in order and will be made during the vintage of 1888, provided Zinfandel grapes of the proper composition can be obtained. In the meantime it will be interesting to compare with the above, the course of the fermentation of two lots of first and second crop Zinfandel obtained from Fresno, through the courtesy of Capt. J. Chamon de St. Hubert; both of which were treated at the laboratory in the usual way, by fermentation under the protection of a floating cover, with an outside temperature of 75°. The subjoined table gives the main data in a summary way; including therein the corresponding fermentations of the series of 1886. The comparisons suffer somewhat from the inequality of the quantities employed; hence the latter are given in the table in order that allowance may be made for them:

TABLE 3. SHOWING FERMENTATION OF ZINFANDEL GRAPES.

No.			Solid Contents.	Acid.	Weight of Grapes, in lbs.	Temperature.		Time.	
						Setting.	Max.	Of Max.	Dryness.
679	1st crop, 1887, Fresno	72° to 75°	23.6	.64	80.5	64°	78°	96 hrs.	170 hrs.
717	2d crop, 1887, Fresno		28.3	.39	120.7	65°	75°	87 hrs.	408 hrs.
561	2d crop, 1886, Mission San José		21.1	.65	230.0	60°	92°	93 hrs.	168 hrs.
799	3d crop, 1887, Mission San José		20.9	.60	56.7	63°	83°	47 hrs.	72 hrs.
800	3d crop, 1887, Mission San José	90° to 95°	20.9	.60	56.7	85°	98°	18 hrs.	48 hrs.
550	2d crop, 1886, Mission San José		21.1	.65	63.0	85°	102°	28 hrs.	48 hrs.

The most striking point in the above table is perhaps the enormous difference in the composition of 2d crop Zinfandel from Fresno on the one hand, and from Mission San José on the other. No two entirely distinct varieties of grapes would show greater differences, and it is hardly doubtful that those in acid and sugar are accompanied by corresponding ones in other ingredients that influence fermentation. Despite the identity of name, therefore, it must be conceded that the divergences in the course of fermentation cannot fairly be attributed to difference in the saccharine strength alone; but it is also true that high saccharine strength is usually accompanied by low acid. Hence, for practical purposes the comparison here given will after all hold good in the main. The table also shows the Fresno first crop to resemble the Santa Clara Valley second crop, both in composition and course of fermentation under a low outside temperature. The higher maximum in the Mission San José sample was obviously due to greater mass (230 pounds against 80.5 in the Fresno sample); nevertheless, the time of reaching the maximum, and total duration of fermentation, are practically the same in both. It will also be noted that as between the second and third crops from the Mission, subjected to hot fermentation, and which were practically identical in composition as well as in the quantities employed in the experiment, the only difference is that in consequence of a somewhat higher temperature prevailing in the hot chamber, the maximum in the 1886 sample was four degrees higher, and hence the time of reaching it somewhat longer, although the time of attaining substantial dryness was the same in both cases.

Difficult Fermentation of the Fresno Zinfandel.—But the data in the table hardly do justice to the remarkable behavior of the Fresno 2d crop. After setting at 65°, it showed no visible movement for nearly 48 hours, although its temperature rose to 70° at the end of that time. Twenty-four hours afterward it reached its maximum of 75.5°, but with only a very moderate show of fermentative energy; and thereafter it began to decline, and at the end of another 24 hours had reached the room temperature, with very slow action. The mash was then warmed up to 84° by means of a warm-water agitator, and resumed action; but after 48 hours more, the temperature had again declined to that of the room and the warming-up was repeated; the same was done on the two succeeding days, and again on the thirteenth day after setting, but without satisfactory results. On the morning of the fourteenth day the tank was "dead." It being obvious that nothing could be accomplished in this way, warm water was now added to such extent that, had it been added to the original mash, the latter would have shown 25 per cent on spindle; at the same time thorough aeration was given by means of the air-pump. Action soon recommenced, and in 4½ days carried the tank to substantial dryness.

It is possible that, had the mash been set originally at 85° instead of 65°, it would have passed on to dryness without further aid under the influence of a higher outside temperature. Such, probably, were the conditions under which the same grapes were fermented at Fresno itself, from which locality no special complaints of difficult fermentations were received. It is equally obvious that, had the dilution which was here made on the fourteenth day been made on the first, the tank would have gone through without trouble, notwithstanding its low degree of acidity. In fact, this 2d crop must was composed, and consequently behaved in fermentation, almost precisely as frequently does the Trousseau, even in the northern parts of the State.

Behavior of other highly Saccharine Musts.—But musts of such high sugar contents are by no means necessarily subject to such disabilities, as was shown very pointedly in the easy fermentation of two other lots—one of Malbeck and one of Serine—the latter exceeding the above sample of Fresno 2d crop of Zinfandel by nearly 1 per cent of sugar. The data for these experiments are given in the table below, together with the records of batches of Trousseau and (true) Ploussard.

TABLE SHOWING COMPOSITION AND COURSE OF FERMENTATION OF MUSTS OF HIGH SACCHARINE STRENGTH.

No.		Solid Contents.	Acid.	Tannin in Wine.	Weight of Grapes, in lbs.	TEMPERATURE.		TIME.	
						Setting.	Max.	Max.	Dryness.
717	Zinfandel { 2d crop Fresno	28.30	.39	.35	120.7	65°	75°	87 hrs.	408 hrs.
709	Malbeck	27.54	.43	.48	115.8	64°	83°	72 hrs.	144 hrs.
767	Serine	29.20	.55	.48	34.3	64°	79°	27 hrs.	144 hrs.
710	Trousseau	30.80	.49	.24	109.0	64°	83°	66 hrs.	*210 hrs.
718	Ploussard	29.67	.41	.20	50.8	64°	†87°	118 hrs.	192 hrs.

* Warmed up on the 7th and 9th days to complete fermentation.
† Temperature raised by means of a hot can, from 77° to 85°, 18 hours before.

The salient fact shown in this table is that while Malbeck and Serine went through without difficulty in the moderate time of 144 hours, or 6 days, notwithstanding that the latter had nearly one per cent more of sugar than the Fresno Zinfandel: Trousseau and Ploussard, with a somewhat higher amount of sugar, went through without requiring dilution, although getting some help by warming-up. Manifestly, had these last been set into a warm chamber from the outset, or had they been exposed to the ordinary temperature of a Fresno vintage, they would have needed no artificial help at all.

It thus appears that *the highly saccharine musts produced in warm climates ferment out best under the high temperature prevailing there;* since the energy of their fermentation is so far diminished by the excess of sugar that the heat developed is not enough to carry the process through at a lower one, unaided. There is not in their case the same danger of killing the yeast by their reaching too high a temperature, that was so well demonstrated in the experiment with Carignane. There is, on the contrary, much danger of the extinction of the vinous fermentation, and of its replacement by the lacto-butyric; as has been shown during the past season by but too many tanks in the northern parts of the State.

But the differences in composition shown by analysis do not adequately account for those in the process of fermentation. The difference in the acid contents of the Zinfandel, Malbeck, and Ploussard is too slight to cause them; and one naturally turns to the other well-known ingredient, tannin, for an explanation, the more as the addition of this substance has been recommended for the promotion of fermentation.

But while this might seem to offer an explanation as between Malbeck and Ploussard, in which the tannin stands .48 against .20, it fails when we come to the Fresno 2d crop Zinfandel; for the latter contains only .13 less of tannin in the wine than the Malbeck (.35), and itself stands .15 above the Ploussard; yet the latter went through in half the time with but a little help, while the Zinfandel refused utterly to ferment out without dilution. In the case of the Serine, standing nearly one per cent above the Zinfandel in saccharine strength, doubtless the higher acid contributed materially to the easier fermentation; and the same factor probably helped the Trousseau to worry through, since it had the advantage of the Zinfandel by a full *pro mille* of acid. But at best it is clear that some undetermined factor, peculiar to the grape variety, the climatic conditions, or both, influences

materially the process of fermentation. The quantity and quality of the nitrogenous substances of the must naturally suggests itself as a probable cause; and it is intended to investigate this branch of the subject (a very difficult one) during the next vintage.

EXTRACTION OF COLOR DURING FERMENTATION.

The progress of the extraction of color during red-wine fermentation is a matter of special interest to the wine-maker, so long as the public demand deep-tinted wines. It is the general impression that the color is the deeper the longer (within certain limits) the wine remains on the pomace; and as such lengthy maceration is inexpedient from many points of view, it seemed important to determine how far the advantage claimed for it really exists. The subject was, therefore, kept under scrutiny throughout the above series of experiments, especially with a view to noting the influence exerted by the several modes of fermenting upon the progress of extraction, and upon the intensity and tint of the wine color.*

As it has usually been supposed that the extraction of color depends materially upon the formation of alcohol and goes hand in hand with it, the somewhat laborious color-observations were not, in the series of Carignane-fermentations, begun as early as should have been done to trace the process in detail; hence it happened that in some of the tanks (notably in the "hot" ones) the maximum tint had been nearly reached before observations began. Upon ascertaining this it was determined to repeat the observations in greater detail in the second (Zinfandel) series, so as to catch the process in its very beginnings.

The two tables given below show the second of these two series of observations. In both, the maximum intensity of color attained is printed in **full-faced type**; and the record is continued beyond the period of fermentation, down to the last date, 7 months from the date of crushing. In the Zinfandel table, the corresponding alcoholic contents are also given, showing the entire absence of correlation between color and alcoholic strength.

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*Diagram of wine colorimeter scale referred to in the text:

Tint.	*Shade.*
Violet-red (v. r.)	Violet-red.
	1st—Violet-red.
	2d—Violet-red.
	3d—Violet-red.
	4th—Violet-red.
	5th—Violet-red.
Red (r.)	Red.
	1st—Red.
	2d—Red.
	3d—Red.
Orange-red.	

For a fuller explanation of mode of measurement, see page 25 of the Report of Viticultural Work for 1886.

TABLE 6. EXTRACTION OF COLOR IN THIRD CROP ZINFANDEL, 1887.

FLOATING COVER FOULAGE.

	No. 799. Room, 72°–75°. Mash, 63°; set at 3 P. M., November 15th.					No. 800. Room, 90°–95°. Mash, 85°; set at 3 P. M., November 15th.			
	Time.	Specific Gravity.	Solid Contents.	Alcohol Estimated.‡	Color.	Specific Gravity.	Solid Contents.	Alcohol Estimated.‡	Color.
First Day		1.0870	20.9	0.0		1.0870	2.09	0.0	
Second Day	11:30 A. M.	1.0870	20.9	0.0		1.0511	16.0	2.4	60.0% 2 v. r.
	1:30 P. M.	1.0870	20.9	0.0	14.5% 4 v. r.	1.0440	14.2	3.3	60.0% 2 v. r.
	4:30 P. M.	1.0855	20.5	0.2	17.1% 4 v. r.	1.0370	7.7	6.6	61.0% 1 v. r.
	9:00 P. M.	1.0828	17.9	1.5	21.4% 2 v. r.				61.0% 2 v. r.
Third Day	3:30 A. M.			1.7†	38.0% 2 v. r.			6.9†	**66.6%** v. r.
	8:30 A. M.	1.0575	17.3	1.8	40.8% 2 v. r.	1.0100	6.0	7.2	59.1% v. r.
	11:30 A. M.	1.0450	14.4	3.2	53.3% 1 v. r.	1.0080	5.6	7.6	54.5% 2 v. r.
	2:30 P. M.	1.0360	12.4	4.2	**55.8%** 1 v. r.	1.0028	4.3	8.3	51.0% 2 v. r.
	9:00 P. M.	1.0180	5.6	7.6	54.0% 1 v. r.	Pressed Nov. 17. Time, 48 hours.			
Fourth Day	8:30 A. M.	1.0035	4.4	8.2	51.0% 1 v. r.				51.0% 2 v. r.
Pressed November 18th. Time, 72 hours.	1:30 P. M.	1.0000	3.5	8.6	50.9% 1 v. r.				
January 10, 1888*			2.7	8.5			2.9	7.8	
December 26, 1887					30.7% 2 v. r.				34.8% 2 v. r.
February 1, 1888					26.0% 2 v. r.				15.4% 5 v. r.
May 5, 1888					18.2% 5 v. r.				20.5% 4 v. r.
June 12, 1888					10.5% 1 r.				20.5% 4 v. r.

* Date of analysis.
† Interpolated.
‡ Upon diminution of specific gravity.

The first salient point in these tables is the fact that in every case *the maximum depth of tint was reached some time before the termination of the active fermentation;* and that despite the continued increase of alcohol, a notable diminution of color took place before the approximate "dryness" that usually determines the time of drawing off, had been reached. This decrease of course continued steadily, but at a different rate for each sample. It is thus obvious that so far as increase of color-intensity is concerned, it would have been utterly useless to defer the drawing off and continue the maceration.

However contrary to received opinions, the uniform testimony of the thirteen fermentations in the same direction is quite conclusive on this point. The only question might be whether the subsequent decrease would be as rapid while the wine is on the pomace as after pressing; but it is not in the least probable that this would make any material difference as regards the final outcome.

Changes of Tint.—The progressive *changes of tint* during and after fermentation are also quite strikingly shown. All the wines begin with a tint lying much nearer to the "reds" of the color-scale than that which they show at their maximum, which generally lies high up among the "violet-reds;" subsequently they appear to lose quite rapidly the violet shade, and the older they get the more they descend toward the "reds" again. Numbers 791, 794, and 796 show these changes very strikingly.

All the color-changes are very much accelerated in the case of hot fermentations. The color is very quickly acquired, but as quickly lost; and in the course of time passes very rapidly toward the orange-reds—the color of port. As all the wines were subjected to the same temperature after drawing off, it follows that this tendency toward port colors is already acquired during the hot fermentation; and as is well known, the change is still further favored by exposure of the wine to the air under the influence of a high temperature, in the warm chamber.

It should be noted that at the last reading, one of the wines—No. 787, fermented at 75°, with floating cover—still maintains the same tint it had in November, namely, the second violet-red, together with the maximum depth of color of all; while the samples fermented at an outside temperature of 95° have all reached the third red, a distance of seven-tenths of the entire color scale. *As the violet-reds are not suitable for ports, it follows that whenever it is intended to make the latter class of wines, time is gained by hot fermentation. While in order to maintain the Bordeaux claret tints, all lying within the violet-reds, a relatively cool fermentation should be used;* the more as the development of the claret bouquet (as is noted below), is also intimately connected with this regulation of the temperature.

It remains to be seen whether the Carignane wines will, in the end, like the second-crop Zinfandel wines of 1886, show a slightly deeper color for the hot-fermented wines at the age of eighteen months.

It can hardly be doubted that all these changes take place much more rapidly in the small (ten-gallon) packages used in the laboratory than would be the case in those holding a hundred times more; and that at the usual time of sale the differences in the depth and shade of colors would be very much less in the commercial wines than was here shown at the end of the same lapse of time. It is also certain that in many cases the maintenance of color is intimately connected with certain blends, which, of course, are usually made early in the wine's history. The study of such combinations will form an important part of future experiments in this field of observation.

COMPOSITION OF THE WINES.

The table below gives the data for the composition of the wines produced under the several methods of fermentation, for several dates, mentioned in the headings.

It should be understood that the "acid" was invariably determined immediately after pressing, in order to observe the changes it might undergo thereafter. But the "body," or extract, as well as the alcohol, being certain to change materially during the completion of fermentation, were not determined until the first racking, in January; the tannin also was, as a rule, left until that time, since at an earlier period other substances (eliminated in the after-fermentation) might influence the determination. In a few cases the alcohol and residuary sugar were, for special reasons, determined at the time of pressing. Such determinations are printed in **full-faced type.**

TABLE 7. ANALYSES OF WINES FROM EXPERIMENTAL FERMENTATIONS, VINTAGE OF 1887.

Number	MODE OF FERMENTATION.		Solid Contents.		Sugar.		Body—January, 1888	Body—June, 1888	ALCOHOL.				TANNIN	Total Acid, as Tartaric.				Volatile Acid, as Acetic.	Fixed Acid, as Tartaric.	Date of Pasteurizing
			At Pressing	January, 1888	At Pressing	January, 1888			January, 1888.		June, 1888.			At Pressing	December, 1887	January, 1888	June, 1888.			
									By Weight	By Volume	By Weight	By Volume								
	Carignane.																			
795	Floating cover, 90°-95°		9.50	6.80	5.78	.50 (June, 1888.)		6.30	**7.23** 7.78	**9.00** 9.73	7.43	9.27	.286	.63	1.47	1.47	1.26	.57	.69	Dec. 21, '87.
797*a*	Floating cover, fresh must added	[illegible]	3.70	3.50	.98		3.50	3.30	**9.90** 9.70	**12.35** 12.09	9.56	11.91	.221	.42		.51	.54	.15	.49	Dec. 21, '87.
795*a*	Pumping air		4.40	3.60	.76		3.64	3.10	**9.70** 9.20	**12.09** 11.45	9.34	11.64	.198	.45		.52	.63	.16	.47	Dec. 21, '87.
797*b*	No. 797, with pomace added		4.00	3.30	1.09		3.30	3.30	**9.34** 9.34	**11.64** 11.64	9.34	11.64	.217	.42		.45	.55	.10	.45	Dec. 21, '87.
787	Floating cover	72°-75°.		3.20		.19	3.01	2.80	10.72	13.18	10.07	12.54	.295	.54		.45	.75	.22	.53	Jun. 13, '88.
788	Single frame, top						3.80	3.60	10.07	12.54	10.07	12.54	.216	.50	.53	.65	.64	.09	.55	Jan. 11, '88.
789	Single frame, middle						3.40	3.30	10.81	13.27	10.35	12.82	.209	.52		.55	.59	.09	.50	May 8, '88.
790	Single frame, pumping over						3.60	3.20	10.07	12.54	10.54	13.00	.220	.52		.52	.77	.27	.52	Jan. 12, '88.
791	Three frames						3.50	2.93	9.92	12.36	9.92	12.36	.232	.54		.49	.68	.24	.44	June 5, '88.
792	No cover, foulage						3.20	3.20	10.35	12.82	10.35	12.82	.191	.55		.51	.53	.02	.51	Apr. 4, '88.
793	No cover, pumping air						3.30	3.30	10.35	12.82	10.35	12.82	.193	.53	.45	.50	.63	.21	.42	Apr. 4, '88.
794	"Morel process"			3.80		.24	3.56	3.30	10.07	12.54	9.92	12.36	.224	.55		.47	.64	.23	.41	June 5, '88.
796	Floating cover, 62°					Traces. (June, 1888.)	3.60	3.60	10.35	12.82	10.35	12.82	.243	.47	.41	.50	.64	.19	.45	Apr. 26, '88.
	Zinfandel—Third Crop.																			
799	Floating cover, 72°-75°						2.70	2.65	8.48	10.58	8.48	10.58	.144	.51		.57	.51	.09	.42	June 5, '88.
800	Floating cover, 90°-95°						2.90	2.85	7.78	9.73	7.78	9.73	.200	.65		.65	.66	.27	.39	Dec. 27, '87.

NOTE.—The figures in full-faced type indicate the result of determinations made at the date of pressing.

Considering, first, the Carignane wines: with respect to *body or extract* (solid contents), it will be noted in the column under this head that the *lowest* body of all is shown both in January and June by No. 787, the "normal" fermentation (with floating cover, at 75°), the figures being 3.01 and 2.80 respectively. The next lowest in June (after the completion of the after-fermentation) was that from the tank, treated according to Perret's method (three frames and no stirring, No. 791), the percentage being 2.93. The *highest* body (3.60) is shown by No. 788 (single frame at top) and by the tank fermented at 62° with floating cover (No. 796). Both of these are cases of very slow fermentation, which according to previous investigations made in Germany tends to produce a larger amount of glycerine than the quick and hot fermentations. Accordingly, both wines show a marked smoothness to the taste. The examination of the actual contents of glycerine remains to be done hereafter; and until this has been done, it would be idle to speculate on the causes of the relatively low body yielded by Nos. 787 and 791.

It need hardly be said the solid contents (6.30 per cent) shown in June by No. 795 (the hot fermentation left to itself) is altogether abnormal, and the nature of the substances forming it can only be conjectured; tests showing conclusively that there is only a trifle of unfermented sugar present.

The remarkable lesson taught by the table in this respect is that *the mode of fermentation may make a difference of four-fifths of one per cent in the body of a wine;* a difference very sensible to the palate, and placing the product into different categories both for blending and drinking purposes.

It will be noted that while the *dry* hot-fermented Carignane samples show no common characteristic in regard to body, the Zinfandel wines show, as in 1886, a higher body for the hot fermented sample.

Alcoholic Contents.—The smallest alcoholic contents are shown by the hot-fermented wines as a group; their average (omitting from consideration No. 795) shows 12.08 per cent against 12.78 per cent in the other nine, or a difference of seven-tenths of one per cent in favor of the cooler processes.

The maxima of alcohol (13.18 and 13.27) were produced in the cases of Nos. 787 (floating cover at 75°) and No. 789 (single frame placed halfway down); both procedures which commend themselves in other respects as well. *The difference between the maximum* (13.27) *and the minimum* (11.64) *is no less than 1.63 per cent.* This will be appreciated by those whose wines are graded by dealers purchasing them, according to the percentages of alcohol they contain, since it will pay for a considerable amount of care given to properly controlling the process of fermentation.

Acid.—(Always calculated as tartaric.) The record shows in respect to acid the same as in regard to alcohol, viz.: a decided deficiency in the hot-fermented samples; the average of these (again omitting No. 795 for obvious reasons) being .43 against .52 in the cooler fermentations, immediately after pressing.

The idea naturally suggests itself that the deficiency of alcohol and acid are to some extent correlative, and arise in part at least from a combination of the two, whereby both disappear from the analytical statement, in the form of compound ethers. The marked vinosity of the hot-fermented samples as compared with the others, sustains this view.

The later determinations of acids are not directly comparable, for the reason that, in carrying the several fermentations to their extreme consequences, it was next to impossible to avoid their becoming somewhat infected with unsound germs, notably with acetic, which were verified by the microscope, and so soon as perceived led to the pasteurization of the samples, to avoid farther changes. The date of pasteurization, given in the last column, affords a basis for judging of the relative soundness of the several products, in connection with the greater or less duration of the fermenting process in the tanks, as given on Tables 2 and 6. The determinations of volatile acids contained in the several wines (all made in June, 1888), show considerable acetification in some cases; while in most of them the fixed acid (as given in the second-last column) had slightly decreased, doubtless from the deposition of tartar. Here again, *the hot-fermented samples required pasteurization soonest*, while the last to show the need of it were Nos. 787, 791, and 794. Considering the long exposure to air in the case of the latter, the "Morel" process, it is rather remarkable that it should have held out so long without showing obvious marks of unsoundness.

Tannin.—The experiments made with 3d crop Zinfandel in order to determine the progress of extraction of tannin, show clearly that both time and temperature are determining factors therein. Hence in judging of the significance of the figures for tannin given in the table, the *duration* of the process of fermentation on the skins must be kept in mind also. The last table, giving a summary view of the results of the experiments, exhibits these relations best.

It will be noted that the maximum of tannin, .297%, was obtained in the "normal" process (with floating cover, at 75°) No. 787; the next to it, .286%, being the hot tank, No. 795, which remained in contact with the pomace for sixteen days, against less than six in the former case. It is not clear why this should be so, nor why No. 797*a*, the companion tank of No. 795, and differing from the latter only in the absence of the floating cover, should have reached only .221 of tannin, despite its long contact and hot treatment. The fact that the highly aerated sample No. 795*a*, differing from 795 only in having been made to resume fermentation by means of pumping air into it, has its tannin reduced to .198 (showing a loss of .08 or eight-tenths of a pro mille), as well as the low tannin of the aerated tanks 792 and 793, leads to the same conclusion already indicated by last year's experiments, viz.: That *aeration is efficient in some way in destroying tannin that has already been extracted.* However difficult of explanation from the standpoint of our present knowledge of the subject, the concurrent testimony here shown seems to settle this point conclusively.

It by no means follows, however, that the good effects of aeration do not in numerous cases outweigh in importance the slight loss of tannin (and color) that may be caused by it; the more as its chief use is or should be during the first two days of fermentation, before any large amount of tannin has been extracted.

Considering, next, the two Zinfandel fermentations, Nos. 799 and 800, we note a general agreement with the results just discussed in connection with the Carignane. The low temperature fermentation has the lower body and the higher alcohol of the two, also the higher acid; but markedly lower tannin. The hot-fermented sample was getting unsound, and had to be pasteurized in December, having at that time already .27 of volatile (mostly acetic) acid; while the low-temperature wine, when pasteurized in June for safe-keeping during the vacation, had only one third as much of volatile acid, six months later.

There is, therefore, a close agreement as to the influence of high and low temperature on the composition of the wines, so far as comparable. Nor does the difference in the original saccharine contents of the must appear to modify these rules appreciably.

QUALITY OF THE WINES.

Under the conditions imposed by the first objects of the experimentation in question—the ascertainment of the influence of external conditions on the course of fermentation and chemical composition of the wines—the exact ultimate outcome in respect to quality could not readily be realized, all the wines having become more or less unsound under the protracted exposure to outside influences that in winery work (with proper care) would have been sooner checked; the relatively small quantities favoring the progress of acetification especially. Although checked by pasteurization so soon as perceived, these faults detract somewhat from exact comparison. Yet the differences in character are sufficiently notable to be readily perceived by any one; and it was, and it is at this time, emphatically true that *no two of the tanks have yielded similar products.* In fact, the differences are, in some cases, so great that few would believe the several wines to have been made from the same grape.

Below will be found, in tabular form, for facility of comparison, the record of the treatment and tasting of the several wines, together with the amounts of wine and pomace obtained in pressing. It is to be regretted that the observations and tastings were not made more complete and systematic; but the pressure of other work rendered this impossible. As it stands, however, the record is quite sufficient to show the salient points in relation to each sample, that should, of course, be considered in connection with the record of fermentation and the table of analyses.

Broadly speaking, the most striking difference is found between the hot-fermented wines and those made at lower temperature; in that the former show a more decided general vinosity at the same age, but throughout lack distinctive character and bouquet. *They tend toward the port character; while those fermented at the lower temperature are more or less distinctly of the claret type,* and show a bouquet varying in kind and intensity according to the mode of fermentation.

On the latter point there is some striking evidence when the samples fermented with and without aeration are compared. Nos. 788 and 791 (respectively with frame near surface, and with Perret's three frames), in which no stirring or aeration of any kind occurred, are markedly deficient in bouquet as compared with all the rest fermented at low temperatures. No. 789, in which the pomace was held down to near the bottom of the tank, leaving the bulk of the wine above the confining grating, does not fall into the same category, since the *entire mass* of the wine was kept circulating between the bottom and the surface and so received a good share of aeration; the difference being that in the two other cases, only the *thin layer* of liquid above the frame was aerated at all, and that too much; so as to render the wine unsound among the very first of the series. There is therefore good reason why the wine No. 789 should be found not only to have a decided bouquet, but a peculiarly agreeable one—to the writer's taste, the finest of the whole series. In fact, were it not that this mode of treatment of the red-wine mash involves much labor in the preliminary separation of must and pomace in order to allow the frame to be fixed at so low a point—there being no practicable mode of depressing it in the previously filled tank unless by special and powerful appliances—the observations made would seem to justify its recommendation as one of the

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best methods when it is desired to avoid the trouble of stirring, without running the risk of acetification, or worse. For as compared with the use of the grated frame *at the surface*, the action is quicker, the alcoholic strength higher, the extraction of color more complete, that of tannin equally so, and the wine as a whole sounder and of better quality.

It need hardly be said that *these advantages may be realized to a greater or less extent according as the frame is more or less depressed below the surface;* the worst results following the placing just AT the surface, in which case a small amount of wine above is steadily exposed to the deteriorating action of excess of air and heat, and in drawing off follows the sound wine into the cask, containing the whole. Therefore,

If the grated frame is used, it should be depressed as low as can conveniently be done.

But the long duration of the process when the frame is at top, and the danger of rendering the wine unsound as well as flavorless, manifestly command that this process should never be trusted with the *completion* of the fermentation, *alone*. Either the wine should be pumped over from below, as in No. 790, which yielded a fair result, though apparently the wine was much predisposed to unsoundness; or the frame should be removed after the violence of the fermentation has subsided and the termination of the process hastened, as well as the quality of the wine improved, by means of *foulage*. Both modifications have been carried out in the winery of Mr. John T. Doyle, at Cupertino, with good results.

As to the fourth method of using the lattices, viz.: "Perret's three frames," it does not seem to offer any compensation for its troublesomeness, in the results attained. The wine is decidedly flat as compared with those that have been subjected to *foulage*, lacking bouquet and character and developing very slowly. The rapidity with which the process is completed redeems it from the reproach of rendering the wine unsound, despite the objectionable thin layer of liquid above the upper frame. The cause of this greater safety is undoubtedly that the thinness of the pomace-layer or cap underneath each frame allows of a gradual intermixture and exchange during the process, so that one and the same quantity of wine does not remain exposed *all* the time, as in the typical "single frame" process, No. 788. The labor of properly fixing the three successive frames is quite as great as is that of placing the single frame halfway down (No. 789); and the latter mode is unquestionably the better of the two. It is then only in respect to the maintenance of a relatively low temperature, that the "three-frame" process may deserve our attention in special cases.

As between stirring or foulage by air-pumping (No. 793) on the one hand, and hand-stirring (No. 792) on the other, the advantage of quality and bouquet seems to the writer to be a little on the side of the latter; but both methods have yielded good wines, the one in which air-stirring was used having the claim of a somewhat higher vinosity, and a shorter duration of the fermentation by nearly two days. Under ordinary conditions it is probably not advisable to use air-stirring after the second day, but simply foulage by hand; and where the air of the winery is foul with floating germs of decaying pomace, or mouldy pomace-caps on tanks, air-stirring is probably best avoided, as it may communicate disease. Foul air is undoubtedly responsible for a great deal of unsoundness in our wines, particularly in establishments where a wholesale mode of procedure renders attention to such details difficult, and the breeze that passes by tainted pomace piles circulates freely in the fermenting house.

As regards the "Morel" process, in which the grapes are used unstemmed, and are gradually crushed by means of a cross-peg stirrer, its use has, in the case of the Carignane, certainly yielded a most unattractive wine, with a flavor so harsh and "earthy" as to repel any refined taste. It is remarkable that despite the long exposure, unrelieved by a floating cover (which might, however, just as well be used), this wine has proved relatively sturdy, and was not pasteurized until June. But sound or unsound, it is in this case too much like a medicinal preparation to be relished by the majority of consumers. It is true that different varieties of grapes differ materially in respect to the influence of their stems upon the wine, and when partially or wholly dried are sometimes a great benefit to special wines. But this season's experience confirms my previous impression, that this mode of wine-making has to be practiced with great caution, and is best avoided by persons not thoroughly posted in wine making.

As to No. 796, fermented with floating cover, but in a steady temperature of 62°, reducing its maximum temperature to about 9° below the average (viz., 85° against 94°), and prolonging its fermentation to the 11th day, it is a good wine, but decidedly behind the rest in its development, showing a lighter bouquet and less vinosity at this time. For the time being it would not be as salable as the rest, but in the end it may overtop them in quality. It would, therefore, not seem desirable in the present state of the taste and market for wines, to restrict the maximum temperature of red-wine tanks to as low a point as 85°, the more as the long exposure creates great risk of unsoundness.

So far as the evidence goes, the most desirable range of the highest temperature (for Carignane at least) seems to lie between 90° and 95° for claret types.

As regards finally the *hot fermentations*, the distinctive character of the wines produced by their aid recalls at once the fact that the wines of hot regions are noted for the same general trait of strong general vinosity, with relatively little of what is properly called bouquet. But while this may in part account for their character, there is a no less important element in the character of the grapes used, whether of varieties specially belonging to such climates, or of more northern origin but changed by climatic influences.

Examples of Differences from Climatic Causes.—On a previous page (under the head of "Zinfandel Fermentations") is given the composition of the must or juice of Zinfandel grapes of the second crop, from Fresno on the one hand, and from Mission San José on the other, and the wide difference in their composition and behavior in fermentation is commented upon. Of course the wines produced from these several grapes are correspondingly different. A similar relation is found between the Carignane from the two localities; and the same is doubtless more or less true of all grape varieties. The annexed table shows these relations in a summary way, together with the record of data from other localities.

TABLE 9. COMPARISON OF MUSTS AND WINES FROM FRESNO AND SANTA CLARA VALLEY.

No.	Variety.	Locality.	Solid Contents.	Acid.	Body.	Alcohol.		Acid.	Tannin.	Color at Pressing.
						Weight.	Volume.			
787	Carignane	Mission S. J.	25.75	.53	2.80	10.07	12.54	.54	.297	68.0
711	Carignane	Cupertino	22.94	.60	2.60	9.05	11.27	.43	.205	30.7
684	Carignane	Fresno	22.10	.45	2.60	8.84	11 00	.52	.220	13.3
679	Zinfandel, 1st crop	Fresno	23.60	.64	3.10	9.20	11.45	.64	.228	30.7
717	Zinfandel, 2d crop	Fresno	28.30	.39	2.80	*9.92	*12.36	.48	.350	23.9
799	Zinfandel, 3d crop	Mission S. J.	20.90	.60	2.65	8.48	10.58	.51	.144	50.9

*Reduced by dilution.

At first sight it would seem that there is a wide difference between the Carignane from Cupertino and Mission San José. This is certainly so as regards the color, which at the Mission is more than double of that at Cupertino; and with it the tannin is 50 per cent higher. But the rest of the variation is palpably, and that of the tannin probably, due to a greater degree of ripeness in the Mission sample, which gives it more sugar and less acid. Had these grapes been gathered earlier they would doubtless have agreed very nearly with the Cupertino sample. But in the Fresno grape the ratio is quite different, for we have quite a low sugar percentage (22.10) and only .45 of acid even then, and an extremely light color. With greater ripeness, the sugar might have increased somewhat, but the acid would doubtless have decreased materially below its observed amount, causing a difficult fermentation and yielding a wine of no special merit. If this sample represents correctly the approximate composition of Fresno Carignane, it would seem best to discard that grape from the local list of desirable varieties. It is here so light-tinted that if it were employed for making a claret, it would have to be blended with some other grape for color alone. But its character is hardly that of a claret grape when grown at Fresno, and it has been properly used by Captain Chamon, as an ingredient for a port-like wine.

Corresponding differences exist between the Zinfandels from the two localities. The fine, large, juicy berries of the Fresno second crop, would with difficulty be recognized alongside of the second crop as commonly seen in Northern California; and the wine it makes is quite as radically different in character. It is obvious that to apply to both, though of the same name, the same treatment in vinification and blending, would be to commit as gross an error as can well occur in wine making.

The first-crop Zinfandel from Fresno does not differ materially in composition from that of the Santa Clara Valley; but its berries are liable to be of uneven size and ripeness; so that at Fresno, the second crop is generally considered the best and the main crop, the pruning being done so as to produce the maximum amount of second crop. This is entirely rational; for had the sample before us been harvested earlier, with sugar at 25 per cent, its acid would have been high up in the forties, at least, and a good fermentation would certainly have ensued—such as, in fact, is usually enjoyed at Fresno. The high tannin contents, however, at once distinguish the Fresno second crop from the more northern product, while its lower degree of color is equally apparent.

It is more than probable that similarly great differences exist between grapes of the same name grown in the Sierra foothills on the one hand, and in the northern Coast Range on the other; and it can hardly be doubted that the difficulties complained of by wine makers in the foothills are readily traceable to that source.

In view of these and many similar facts already known, it is hardly too much to say that until the peculiarities of each grape variety in each region are well studied and understood, and the degree of maturity at gathering, together with the method of fermentation, understandingly adapted to the local conditions, grave and expensive mistakes and uncertainties in the outcome of vinification are unavoidable, and a uniform product cannot be offered the wine merchant or consumer.

The fundamental importance of systematic experiments to determine the nature of these differences and the proper adaptations of the several varieties in each region, is thus clearly apparent. To determine the proper treatment and uses by mere blind experimenting without the aid of chemical analysis and instrumental measurements, would involve a long

1	Total	[illegible]	[illegible]
	Volatile	.14	.05

It will be noted that the maxima of temperature were reached by both at the same time, but the aerated sample was four degrees cooler than the other, and afterward completed its fermentation 120 hours before it. This difference is of course much greater than can under existing conditions be accounted for by the additional 2 per cent of sugar, and it was made more striking by the sharp termination of the action in the case of No. 750, in contrast to the long protracted slight "sizzing" of No. 745. Not less notable were the quicker clearing and rapid development of bouquet in the former as compared with the latter; and the analysis shows that no undue proportion of volatile acid was formed in consequence of the aeration, although in deference to microscopic indications it was pasteurized on January 31st.

The aeration given in this case was intentionally made excessive in order to bring out the effect more plainly, and the wine showed the result of this excess both in its deeper color and in a somewhat unusual quality of the bouquet. In the long run the wine No. 750 would probably come out softer and smoother to the taste; but No. 745 would unquestionably be soonest salable and ready for the bottle.

These results are of course not unexpected, and the experiment was made simply in order to put on record the fact that, contrary to the belief of some, the experience of Europe in these matters is directly applicable in California, also.

BEARING OF THE FOREGOING EXPERIMENTS ON LARGE-SCALE PRACTICE.

It has so often been alleged that small-scale experiments can be no guide for large-scale practice, that it may not be superfluous to discuss this question here, and to point out where and how the facts and principles illustrated above find their direct application in winery practice.

First, as to the general issue, it is historically certain that all useful inventions and modern improvements have had their origin in small-scale experiments. It cannot reasonably be otherwise, for large-scale experiments are too costly to be liberally indulged in, until their outcome is made reasonably probable or certain by the experience gained on the small scale. If we had to wait for large-scale experiments, our industrial progress would be very slow; nor is there any reason why, with a proper understanding of and allowance for different conditions, the small-scale experiment should not clearly indicate the general principles and practice of large-scale work. Many details will remain to be elaborated in the factory, but the principles devised in the laboratory will hold good there as well. To illustrate, it was not necessary for a liberal-minded gentleman to plant experimentally 500 acres of sea-island cotton, near Williams, when one fifth of an acre would have shown just as well the impracticability of that particular culture in that region. It is the province of experimental work to save such unnecessary and injudicious expenditure, by small-scale experiments made under well-ascertained conditions and competent supervision.

Winery Experiments.—Coming to the matter in hand, it has been suggested and somewhat persistently urged, that experiments such as those recorded above must be made in a "real winery" in order to have any bearing on large-scale practice.

The answer is, *first*, that the onus of proving that experiments made on the scale adopted—taking the 50-gallon tank as a unit—will when properly managed and interpreted fail to be applicable to practice, rests on those who assert the alleged insufficiency. *Second*, that the expense involved in carrying on experiments on a "winery scale" would be so great that they would either not be made at all, or only one or two at a time could be managed, and the eliciting of useful results would be indefinitely delayed. We can afford to spoil quite a number of 50-gallon tanks of wine; but it would put the generosity of wine-makers or taxpayers to a severe test if they were asked to supply materials for and risk 1,000-gallon tanks, for the general good. Witness the extreme reluctance with which any proposition to conduct even very simple and safe experiments in wineries is usually met; and the imperfect manner in which, even when permitted, they are mostly carried out under the pressure of vintage work and fear of loss, added to the difficulty of properly controlling the conditions of such experiments amid the opposite requirements of scores of other tanks alongside.

When, on the other hand, the probable outcome of a certain mode of operating is settled beforehand by small-scale experiments, wine-makers will generally agree easily to test the matter on a sufficiently large scale to settle the question practically and conclusively. This is precisely the object of experiment stations.

Influence of Temperature on Fermentation.—One of the main points aimed at in the comparative experiments recorded above is to test the influence of *temperature* on the course of fermentation; because the controlling influence of this factor, so well established elsewhere, has been so persistently denied here, and mysterious influences have been suggested in place of what was readily explicable on well ascertained premises; thus leaving the wine-makers "at sea" as to possible preventives and remedies.

In our experiments the means adopted for controlling the temperature of the tanks was, first, *that of the mash when set;* second, *that of the surrounding air;* third, *the use or omission of covers on the tank or mash;* fourth, *stirring*, either by means of *wooden implements* or by *pumping of air;* fifth, *the use of warm or cold water contained in close vessels*, or in circulating spirals suspended by rubber hose.

Any or all of these means or appliances can be and are used on the large scale in European countries, for the same purpose.

The Setting Temperature.—In practice, probably, the greatest influence on the temperature of the tanks is exerted by that of the mash in setting; for the masses being large, the temperature so introduced is more tenaciously retained than would be the case on the small scale. It is true that the temperature of the surrounding air counts for something even in 2,000-gallon tanks, but of course much less than the tables above show to have occurred in the case of the 50-gallon tanks, where a difference of 18° in the outer air caused one of 16° in the maximum attained during fermentation. (See Nos. 787 and 796, Carignane series.)

Now, when it is considered that in the Carignane fermentations a difference of 9° (between 96° and 105°) made all the difference between two tanks completely "stuck" (795 and 797), and one that went through most rapidly of all (No. 787), the importance of these two factors—the setting temperature and that of the outside air—becomes amply obvious. It remains for objectors to show that the heat of 105° that "stuck" the 50-gallon tanks would not have equally stuck the 2,000 or 10,000 ones; or that tanks of that size in which the temperature had been kept down to 96° or below, would not have gone through as glibly as did No. 787. Yet that difference might have been amply made up by setting one tank with mash at 62° in the morning, and another at 75° in the afternoon. How many wine makers are there in California who have paid attention to such differences as these?

Low and High-Grade Musts.—But the Carignane was a high-grade must, of nearly 26 per cent of sugar. The same conditions of temperature applied to third-crop Zinfandel, having only 21 per cent of sugar, did not only *not* result in "stuck" tanks, but sent the fermentation through with surprising rapidity; and this happened in the experiments made independently, in two consecutive seasons, so that there cannot well be any question about the fact. In 1886 the Zinfandel mash reached 103°, and yet went through without "sticking;" within three degrees, therefore, of the heat that completely paralyzed the yeast in the case of the Carignane.

How many of our wine-makers know this fact and act upon it in the treatment of their tanks? True, all know that weak musts go through more readily than rich ones; but how many are there who consciously attempt to control the temperature of their cellars, grape mashes, or tanks with that view, and treat differently the weak and the rich musts in this respect? And, failing to do this, is it any wonder that when a hot norther sets in during the vintage, the greater concentration of the must and its higher temperature should bring about the sudden difficulties of which we have heard so much during the past years? How many have used the thermometer conjointly with the spindle, in order to know how hot they could afford to let the tanks become? How many, in fact, know anything at all about the degree of heat actually attained by their tanks?

The difference between the 21 per cent of sugar in the Zinfandel must and the 26 in the Carignane, having made all the difference between a rapid fermentation and a completely "stuck" one, under the same outside conditions, it follows that between these two strengths of must there lie very many combinations of varying strength, temperature, and acid contents, that will influence for weal or woe the course and outcome of the fermentation. It is very well established that high acid contents facilitate a sound vinous fermentation; then of course, a must having high acid may be higher in sugar also and still go through under trying conditions; whereas one with lower acid and even lower sugar may become "stuck" under the same circumstances. The wine-maker should therefore know how he stands in these respects, in order to govern his wine-making intelligently.

European Practice.—But objectors say that the wine-makers of Europe have made good wines for a thousand years and have known nothing about all these things; then why should we?

In the first place, as a matter of fact, a very large proportion of the wines made in Europe are very far from being the best that could be made under the prevailing conditions; a fact certified to by every œnologist of that continent.

Secondly, the experience of centuries has there taught the wine-makers of each region how to treat their wines, by rule-of-thumb, so as to make a fair article, suited to *their* taste at least.

But now that rapid communication is opened up between remote districts and their wines are compared by the general public, the faults of the local products are brought to light and œnological stations are struggling with all their might to overcome the bulk of vicious old habits.

As yet we have in California no settled rule-of-thumb that may not be readily gotten rid of among a progressive population, *by proper instruction in the principles of wine-making, which hold good everywhere, no matter how the material and the practice may vary.* We have to do almost altogether with new materials—grapes grown out of their habitual climatic surroundings—and we cannot safely follow *any* local European precedents blindly. But we must equally avoid running after jack-o'lantern lights that pop up here and there and claim to have found a panacea for all the ills that wine is heir to, which is just as irrational as in the case of human ills. We must fall back on principles instead of rule-of-thumb; and principles can only be the result of close study, not of wild guesses based on general notions.

Some may Succeed under Unfavorable Conditions.—Again, under these points of view it is easily intelligible now in certain localities, and with particular kinds of grapes, good wine has been and can be made under the shelter of an oak, or of a shed through the chinks of which the stars may be seen at night. With a must of moderate sugar-contents, high acid, and started in at a high temperature, there is no reason why it should not go through "flying" in a short time, and when taken care of make an excellent wine. But apply the same mode of procedure to more highly saccharine musts, like those mentioned above, and there would be utter failure under such conditions. Hence it is not well to make a rule of the exception, and to recommend for general practice arrangements that fail to give the wine-maker control of temperature. When this can be regulated without a close winery, the latter may be dispensed with; but the temperature remains the governing factor notwithstanding. Safe voyages are not uncommonly made in unseaworthy vessels, but it can hardly be contended that, therefore, such vessels are safe, or usually prove good investments.

Controlling Importance of Temperature in Fermentation.—The entire series of experiments speaks pointedly and unmistakably of the preëminent importance of *temperature* in wine fermentation, and of the necessity of watching and controlling it in order to secure definite and satisfactory results. The narrow interval that separates the temperatures at which the yeast is paralyzed, from that at which it is still highly active, and the variation of this factor together with that of the saccharine strength (likewise effective in changing the course of fermentation), accounts sufficiently for the great bulk of the unexpected and unexplained difficulties encountered by wine-makers who disregard the management of temperature, trusting to haphazard for the outcome.

In all the other industries dependent upon fermentation, such as brewing, whisky making, etc., and not less in the operations of a well regulated dairying establishment, the thermometer is ever in the hand of the attendant, so as to insure the exact maintenance of the proper degree of heat throughout the process. It is difficult to see why that which is so great a need and safeguard in these processes, should be set aside as unimportant by the wine-maker; and the notoriously uncertain quality of his product should admonish him that while certain peculiarities of wines are inevitable results of conditions of soil and climate, a very large part of what is commonly ascribed to these influences is really due to variations in the conditions of fermentation, such as are exemplified in the above series of experiments. Analyses showed them all to differ very perceptibly in composition; and the palate of the taster readily recognized corresponding differences in their quality.

The brewer not only knows that such differences are brought about by the conditions of fermentation, but he consciously utilizes the knowledge for the production of certain preferred qualities in his product. Is it not truly strange that the more valuable product—wine—should in this respect be prevalently left to the accidents of the season, or even of the time of day at which the fruit happens to be brought in from the vineyard; going into one tank cold from standing over night, into another hot from the noonday sunshine, often making differences of fifteen and even twenty degrees in the starting temperature, which, as the above experiments show, is ample to bring about the most serious differences in the course of fermentation; may carry one through to dryness rapidly, while the other, right alongside, becomes hopelessly "stuck." Then we hear of unaccountable irregularities of fermentation, and all kinds of nostrums are recommended to remedy what in reality requires nothing more than a moderate exercise of common sense, in addition to some knowledge of the principles of fermentation and a use of the easy means, now accessible to every one, of verifying the external conditions under which the wine is being made. No wonder that the wine of each tank is so different from its neighbor that the consumer fails to recognize the identity of the wine he orders "as per sample," and which the maker can truly say is identical so far as *he* knows, but which nevertheless has actually undergone quite a different process in the winery. No wonder California cannot "duplicate samples" so as to satisfy the purchaser, while such utter disregard of first principles in wine-making prevail so widely!

What is to be Done About It?—If it be asked how such difficulties are to be avoided in practice, under the pressure of the vintage, the answer is that in the first place, the producer should not undertake to make more wine than he can manage successfully, so as to turn out a properly merchantable product, which shall not stand in need of undergoing all kinds of uncanny manipulations necessary to deceive the palate of the consumer. *The conditions of an overcrowded winery are not reconcilable with good quality of the product.*

In the second place, *so soon as the wine-maker is in earnest about the observance of the proper conditions* for obtaining a sound and uniform product, there are a great many ways in which (*leaving aside for the present the avoidance of acetification*) the equalization of temperature conditions can be brought about. Thus, the tanks into which hot grape mash is run may be only partially filled for the time being, giving a large surface for cooling-off before the fermentation sets in, and afterward filling up with the cooler mash of subsequent crushings; or, smaller tanks may be used for the hotter portions than for the cooler; or, more abundant stirring may be used in order to depress the temperature. For warming-up mashes that are too cool, as often happens in the mornings, the warmer mash of later crushings is commonly available for producing the exact temperature desired; or, the cool mash may be covered so as to cause the warmth caused by incipient fermentation to be maintained; or, it may be urged on to quicker action by aeration, specially with warm air; or, finally, it may, as a last, but by no means desperate resort, be *warmed-up* bodily by means of a warm water coil connected with rubber hose, and provided with convenient handles for two men. The same arrangement will serve as well for the *cooling down* of tanks whose temperature is rising too high, by means of a stream of cold water. In any and all cases, the method of fermentation may be so varied for each tank as to conduce to the maintainance of the proper degree of heat, as shown in the above tables.

It is idle to say that this involves too much trouble and expense. That is the same cry that is raised wherever the soil is giving out; viz.: "manuring is too costly and will never pay." And yet it *must* pay, or else the land must be abandoned; and experience the world over shows that it *does* pay. It certainly will not pay to continue to make unsound and uneven wine, for which the maker can barely realize the prime cost because it is unsalable until subjected to many costly and objectionable manipulations, which in the end cannot prevent it from spoiling the reputation of the product of the State in the world's market. It is an old and well known story that any wholesale system of agriculture, "planting," as it is usually termed, tends to waste and deterioration, both of the soil and of the product; and this is *a fortiori* true in the case of wine production, where quality is so strongly insisted on by the consumer, and that quality is attainable only by close attention to details, all the way from pruning and cultivation to the bottle. It is a mere question of time when we shall settle down, in these respects, to the careful habits of the old wine-producing countries. However great the differences in their grapes, wines, and methods of production, *minute care in the entire process*, for the purpose of insuring certain desired qualities, is almost universally practiced; and the sooner we can at least approximate to a similar system, the sooner will the wine industry be placed on a sound and firm basis, instead of the periodic depressions to which it is now subject, and which tend to discourage all improvement and drive the small producer into bankruptcy.

PASTEURIZATION OF WINES.

In February of last year a bulletin (No. 66) was published, giving in a summary manner information on the subject of the pasteurization of wines; that term having been adopted for the treatment devised by Pasteur, for the final repression of all fermentative action in wine, of whatever kind, by the application of a moderate and strictly guarded degree of heat, under complete exclusion of air.

The peculiar conditions under which the vintage of 1887 was made, involving the introduction of much unsound material into the wine vats unless carefully hand-picked beforehand, together with the frequent use of overripe grapes, combined to make an unusual proportion of wines that, if not unsound at the very outset, were exceedingly liable to become so under the slightest provocation. There thus arose so heavy a demand for information on this, the best and most thoroughly legitimate mode of preserving wines from injurious germs, that the edition of Bulletin No. 66 was soon exhausted; hence it is reprinted here for the information of wine-makers, and with the strenuous recommendation that at least no winery intending to age wines should remain without having at command a pasteurizer of sufficient capacity to allow of prompt interposition, not only in cases of actual and obtrusive unsoundness, but whenever a suspicion of danger arises. Such danger will be of very common occurrence so long as the practice of fermenting with free access of the hot air of our vintage season to the uncovered pomace cap, or to the thin layer of wine on top of barely submerged grated frames or "false bottoms" continues to prevail. All who have analyzed California wines, or examined their sediments with the microscope, must testify to the wide prevalence of the acetic taint especially. The latter mode of examination is so wholly within the power of any person of ordinary intelligence, and defines the condition of the wine with such absolute certainty, that it is greatly to be regretted that the microscope should not, with the must spindle and mash thermometer, form a more common appliance in all well-regulated wineries. It might seem too "bookish" and "unpractical" to a great many; but those availing themselves intelligently of its services would soon be amply rewarded for their expense and trouble in saving wines from progressing too far on the way to unsoundness. It will indicate the propriety of resorting to pasteurization long before the most delicate taste can recognize any fault in the wine.

It cannot, however, be too strongly enjoined upon those who desire to avail themselves of pasteurization, that at least for all bouquet wines, in which some quality is expected to be maintained, a sufficient *length*, and sufficiently *small diameter* of the heating coil, and ample cooling power, be looked to. The pipe should in all cases be of block tin, not over half an inch, and preferably less, in (clear) diameter; and the greater its length, and the mass of the heating water bath, the less liability will there be to injure any portion of the wine by imparting a "cooked" taste. *A short and wide heating coil involves the use of a high temperature of the bath,* if the output is to be resonably large; and this is liable to lead to overheating of the exterior portions of the passing wine, while interior threads may possibly escape adequate heating, and thus remain to reinfect the wine.

Adequate cooling power is very essential in order to prevent any contact of *warm* wine with the air; and the emerging stream of wine should not be allowed to "break" as it passes into the receiving cask, thus avoiding unnecessary aeration. Strict attention to these points will greatly abridge the period of "flatness" that follows pasteurization, and requires from three to eight weeks to subside. It is useless to taste a wine immediately after pasteurization; for it then holds in suspension the sediments brought down by the heating, which impress the palate so much as to render a judgment regarding the result of the operation impossible.

Pasteurizing, like all other operations in handling wine, requires a little experience, both in the management of the temperature and the maintenance of the best conditions for the welfare of the wine. Pumping directly into the coil is altogether undesirable; the wine should be pumped or run into a receiving cask, from which it descends through a siphon at a nearly constant pressure, greatly facilitating the maintenance of a steady temperature. For California wines the latter need rarely exceed 150°, as their alcoholic strength is almost always high enough to insure complete disinfection at that point.

The fining of wines after pasteurization should always be deferred for some weeks, in order to assure the coming-down of all the sediments prior to fining. In many cases the sediment comes down so promptly and in such compact form that, in small packages at least, no fining is needed, and the simple filtration of the turbids after racking is preferable.

It is intended to give cuts of several of the best forms of pasteurizers in the final report on the past season's work, it having been impracticable to prepare them in time for the present publication.

Bulletin No. 66.

THE PRINCIPLES AND PRACTICE OF PASTEURIZING.

The numerous inquiries now being received in regard to the practice of, and appliances needed for pasteurizing of wines, render it expedient to put in print, for general information, the main points in the premises.

The essential point to pasteurizing is to heat wine to the temperature of 150°, or thereabouts, out of contact with air. This heating should be done as quickly as possible, and after the proper temperature has been reached it is best, other things being equal, to cool the wine as quickly as possible.

Several objects are accomplished by this heating. The one most generally aimed at is to kill the germs of all kinds of fermentation that may exist in the wine, in order that it may be safe from further changes under their influence. Another is to advance the wine toward maturity. Also, to forestall any further deposition of sediment, by the coagulation of the albuminous matters it still contains, and which endanger its soundness.

The general plan in the construction of pasteurizers is usually the same as that of the various kinds of still condensers; only, in this case the water around the worm is hot, and the cold wine in passing through the worm is heated to the proper point by allowing it to move with greater or less rapidity, in a solid column, so that a thermometer inserted at the exit end will show steadily the desired temperature. Beyond the thermometer, the wine passes into a cooler, from which it is delivered into the (well-cleaned) storage or shipping packages. In many cases, it is delivered into these directly from the pasteurizer, and allowed to cool in the tightly bunged casks.

Wines of sufficient age, that have ceased to deposit sediment and are bottle-ripe, may be pasteurized in the bottles themselves, in a water-bath having the proper temperature. This is the preferred practice in the case of high-class wines.

The temperature must be carefully guarded, since if it either rises too high, or continues too long even at its proper point, the wine may acquire a "cooked" taste, and may lose its natural bouquet. Immediately after the operation the wine is somewhat flat, but in the course of a few weeks not only fully recovers its zest, but is found very much advanced toward maturity.

The Rationale of Pasteurization.—The effects of this process upon the wine may be thus summarized:

1. All fermentative germs, of whatever nature, are killed by the heat; the more promptly the higher the heat and the alcoholic contents of the wine. Wines poor in alcohol, and especially those containing a remnant of sugar, require a higher temperature than those fully fermented out and rich in alcohol.
2. Acids present in the wine are, under the influence of the heating, partly neutralized by entering into combinations (ethers) which form part of the flavors of older wines. Hence, acetified wines become of milder taste at once, and even milksour ones gradually lose their "scratchiness," if not too far gone.
3. Wines while maturing in the cask are always found more or less impregnated with atmospheric air (oxygen), the gradual absorption of which forms a most essential part of the maturing process. After pasteurizing, the wine is found free from oxygen, proving that it has been absorbed during the process, thus often accomplishing in a short space of time an advance toward maturity that at the ordinary temperatures would have required several months.
4. When the heat is raised sufficiently high (to about 160°, which can be done without injury to most classes of wine), the unstable "albuminoid" substances of new wines that continue to cause the formation of deposits of lees, for one or even two years after the completion of the vinous fermentation, are at once rendered insoluble, and thereafter cease to give trouble; the wine, after having been cleared by settling or filtration, forms no more deposits, and can, if necessary, be bottled.

It should be understood that while pasteurization puts an end to all further fermentation, it does not interfere in the least with the ordinary process of maturing in the cask. But, save in cases of emergency, it must not be practiced before the completion of the after-fermentation.

Should a wine, however, be found to be "going wrong" while the after-fermentation is progressing, it may be pasteurized to stop farther damage, and will then be ready to be started on a healthy after-fermentation the following season, or sooner if the materials (*e. g.*, condensed must) are at hand.

Pasteurization thus stands in lieu of any and all *antiseptics* heretofore used in the wine itself; it should replace sulphuring no less than salicylic acid. Of course, sulphuring will always be eminently useful in the cleansing or disinfection of caskage, and remains indispensable in clearing the cellar of foul germs.

Precautions Necessary to Insure Success.—While a well-pasteurized wine is secure against further action of the ferment germs previously contained in it, it is, like any other wine, subject to reinfection from foul packages, bungs, pumps, hose, etc., as well as from impure water and air. Impure water used in rinsing packages is a fruitful source of trouble, and the bottling of wine in close, musty, unventilated, and unsulphured cellars is responsible for many bottles of damaged wine, especially if the corks used have not been scalded in hot water. From want of these reasonable precautions it has often been reported that pasteurizing is not the universal cure for wine diseases that, with proper care, it has always proved to be. Just as a dose of quinine cannot permanently prevent the denizens of malarious valleys from contracting chills and fever, so Pasteur's admirable process does not secure wine against injury from carelessness and filth.

The Practice of Pasteurizing.—Among a score of varied appliances brought forward by different inventors, a few only have gained wide acceptance. For California practice the "intermittent" patterns will hardly be considered. Of those intended for continuous operation, which alone are adapted for large-scale practice, there are essentially two types. In one (including the "oenotherms" of Terrel des Chênes and of Carpené) the cold wine passes through one or several metallic (block tin or copper-tinned) pipes immersed in water heated by proper furnaces or by steam; in the other the pipes are replaced by a ring-shaped space between an inner and outer cylinder. The former system has, on the whole, been more generally accepted.

As has been stated above, the overheating of any portion of the wine must be carefully avoided. Hence the temperature of the water-bath must not greatly exceed that desired for the wine, since otherwise the outside portions would, in traversing the pipe, be heated up too high, and therefore be "cooked." (The same objection lies against heating the wine in a closed tank by means of a steam coil, as has sometimes been done.) Hence, again, large pipes are unsuitable, as the temperature would be taken too slowly, and as a single small pipe would reduce too much the working capacity of the apparatus, the inlet pipe is made to branch into a number of these, disposed in the form of either a ribbon or a loose bundle of coils. In Terrel's apparatus (which may be considered the most perfect) the cooler is similarly arranged.

For ordinary purposes, however, this complex and somewhat costly construction is very commonly replaced by a single pipe forming a long coil of somewhat greater diameter than those in Terrel's apparatus; and this form, being easily constructed by any plumber, is sufficiently well adapted to the needs of small producers.

At the winery of Mr. Juan Gallegos, near Mission San José, a pasteurizer of satisfactory working and output, consists of a 90-gallon "farm boiler," within which is placed a coil consisting of 130 feet of ½-inch block-tin pipe, held in form and position by four straps (U-cross section) of strong galvanized sheet iron, to which the coils are soldered, so that the whole can be freely handled and taken out of the boiler when not in use. A similar coil in a wooden tank forms the cooler, and the capacity of the apparatus is about 950 gallons per day (ten hours).

The pasteurizer in use at the viticultural laboratory of the University has a coil of ¼-inch block-tin pipe, 30 feet long, immersed in a 15-gallon boiler; a 20-foot coil of the same pipe forms the cooler. The capacity of this single pipe is 8 to 10 gallons per hour when the tank water is kept at about 160°; with ten similar tubes and a bath temperature of 170° (which is admissible for many wines); in a 100-gallon boiler, the hourly capacity would be over 100 gallons, or say 1,000 gallons in ten hours.

A large apparatus according to Terrel, with a capacity of 250 gallons per hour, costs at the factory $240.

In order that any of these appliances may work with perfect regularity, it is best that the wine should descend by gravity from a supply cask, adjusted once for all to such a height above the heater as to form a proper pressure column; into this supply cask the wine to be treated is pumped as needed. Pumping the wine directly into the heater is objectionable because of the spasmodic action, by which some portions of the wine may escape adequate heating, while others are overheated. For the regulation of the flow to the exact temperature desired, a faucet (tinned inside) is interposed between the cask and the heater; it is convenient to have another placed between the heater and the cooler, or the receiving cask. The inlet pipe must descend to the bottom of the heater, so that the wine moves *upward* in the spiral; otherwise accumulation of gas bubbles causes irregularities. When a cooler is used, fuel may be saved by using in it, instead of water, the wine that is to be heated and may thus be given a part of its increase of temperature.

It will thus be seen that pasteurizing is an exceedingly simple operation, which can be performed by any intelligent laborer who can read a thermometer and adjust a faucet.

Utility of Pasteurization.—When it is considered to how great an extent the general use of the pasteurizing process can do away with the most serious difficulties under which California wine-makers labor, its importance can hardly be overestimated. Our hot vintage season and the imperfect methods of fermentation still so commonly practiced, render our wines peculiarly liable to the introduction of noxious germs, which develop so soon as the after-fermentation is completed, if not sooner. Pasteurizing will put a final stop to these dangers, provided proper care and cleanliness is used in handling them afterward.

It is the common practice to ship our wines when very young, and they go to long distances and pass through great alternations of temperature. Once pasteurized, they will stand this treatment without material danger or deterioration. If given rest for some weeks after the process, they may be fined, if necessary, and will arrive nearly as clear as they left the shipper.

One of the most serious sources of complaint against California wines in the East is that they "will not keep," the cause being very generally the fact that, being too young to be bottled like imported wines of greater age, they undergo unsound fermentation in the bottles, as they still contain germ food, and possibly germs of all kinds. All this is done away with by pasteurizing, without the need of salicylic acid and without injury to the wine.

I believe that when these matters are fully understood by our wine makers and shippers, the pasteurizing of wines before shipment will become the rule instead of the exception. A prudent shipper dealing with valuable wines, of the perfect soundness of which he has the slightest doubt, will not jeopardize his pecuniary interest and his reputation by omitting so simple and inexpensive a means of insuring their perfect safety. Wines made with all proper precautions may still go, unscathed, as they come from the storage casks; but even the additional "age" imparted by Pasteur's process will, when wines are properly graded and valued, generally pay for the labor involved.

But all inducements toward the improvement of our product vanishes so long as the wine dealer continues to preach and act upon the maxim that "wine is wine" in his dealings with the producer. The communistic principle is fatal to all individual improvement and progress, whether applied to society or to wine production; it stands next to adulteration and "stretching" in barring the progress of the wine industry in California.

BERKELEY, February 25, 1887.

RED WINE FROM CONDENSED MUST

BY THE SPRINGMÜHL PROCESS.

In view of the interest attaching to evaporated must and pomace preserved according to Springmühl's process,* as opening a market for grapes without the heavy investments required for wineries, I think it proper to communicate at this time the results of an experiment made during the past season, with a barrel sample of the condensed must (with pomace) sent to the University Laboratory from the Geyserville factory, by Dr. Springmühl.

It should be stated that the arrangements at the factory were far from being altogether satisfactory, on account of the haste in which the various appliances had to be gotten together. While the condensers worked as well as could be desired, there was a deficiency in press power, in consequence of which the pomace could not be pressed as dry as is really required for the best results; nor could the two condensers be worked up to their full capacity. The grapes supplied to the factory could not be selected at leisure but had to be taken as offered, without nice discrimination in respect to kind and even quality. A good deal of the stock supplied would, under the ordinary treatment in wineries, and in the absence of pasteurizing arrangements, certainly have yielded very inferior and unsound wine. The entire work was therefore conducted under the most unfavorable conditions, and a satisfactory outcome will weigh heavily in favor of the value of this method of utilizing our surplus of grapes that cannot find winery accommodation.

The contents of the package, at first sight resembling grape preserve, consisted of evaporated must or grape syrup already mixed with the proper proportion of skins or pomace; as was ascertained by a special determination. The grapes represented were, according to Dr. Springmühl's statement, about half-and-half Zinfandel (first crop) and "Burgundy." The identity of the grape so called I have been unable to ascertain; it was doubtless not a Pinot, but probably Chauché Noir, possibly Trousseau. The light color of the wine speaks of some such light-tinted grape.

The spindle showed the solid contents of the syrup to be 72.6 per cent; acid (as tartaric) 1.17 per cent.

On November seventeenth (about a month after receipt of the package) 33 gallons of the condensed must, plus skins, were reduced by the addition of 60 gallons of distilled water, to 24.2 per cent of solid contents and .39 of acid. This regenerated grape mash was divided out among three tanks, for convenience of testing several modes of fermentation. All were "set" at a temperature of 63°, and placed in the fermenting room kept at 72° to 75°. All three were provided with the floating cover; one was treated with ordinary "foulage" from the beginning, three times daily; the two others were stirred by means of air-pumping during the first two days, then simply stirred as usual.

It soon became apparent that all fears as to the automatic starting of the fermentation were groundless. Within 18 hours a perfectly normal fermentation was going on in all three tanks; but one (started 18 hours after the others), from some cause, lagged a little and reached its maximum temperature, as well as the 4 per cent of solid contents determined upon as the mark for drawing off, 18 hours later in actual time. The maximum temperatures attained were respectively 91.5°, 92.5°, and 93°, reached by the first two tanks on the morning of the fourth day. After that the temperature rapidly declined, and the pressing was done respectively after the lapse of 115, 120, and 146 hours; the tank subjected to ordinary stirring being the first to come in.

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* For a detailed account of this process, see the report of viticultural work for 1886, pp. 47 to 51.

The fermentation was so completely normal that no one would have suspected that the mash was not made from fresh grapes; and that despite the fact that the must had undergone evaporation at a temperature too hot for the hand to bear, and which would ordinarily be supposed to paralyze or kill all fermentative germs. Yet evidently here there was no lack of them, and no yeast of any kind was needed for starting. The table below gives the summary record of the course of fermentation, as well as the analysis of the wine.

The wine was quite light-colored, the maximum tint being 16.6, reached on the fourth day. At pressing the tint had already declined to 12.5 in the first two tanks, and had hardly changed from the maximum (of 14.6) in the third. The cause of this difference is not obvious; it disappeared afterward.

In the after-fermentation, also, these wines behaved normally; and on February 7th they were racked and combined into one sample of 70 gallons, there being no difference worth noting in the three packages.

At this time the wine showed to the taste a curious combination of advanced vinosity with the yeastiness of the new wine, and its very marked astringency was coupled with a slight bitterness that seemed to augur ill for the quality of the wine.

Thenceforth it was frequently tasted, and the gradual disappearance of the bitterness first noted was evident. At the beginning of June the wine was again racked; an examination of the sediment at this time showed complete soundness.

A tasting record of June 16th, states that "the bouquet is developing; astringency pronounced, but pleasant; acid agreeable; no bitterness remaining." (M. E. Jaffa.)

A somewhat critical tasting made by the writer on July 11th, was recorded as follows: "Fairly developed bouquet and vinosity; acid normal and agreeable; no mark of unsoundness; wine, as a whole, well developed for its age, and of very fair quality and clean taste; has lost completely the bitterness first noted, and while showing little of the characteristic Zinfandel bouquet, would not be suspected of any unusual procedure in its preparation."

Under the circumstances, this result must be considered a very favorable one. It is true that the wine shows no high quality, but will be a good, ordinary table wine, a great deal better than those commonly dispensed in restaurants, or even in more ambitious places. With the materials used, few wine-makers would have succeeded in producing anything better, if as good. What can be done with perfected appliances and selected materials remains to be seen; but the advantage of having the making of the wine transferred to establishments able to employ competent wine-makers, and to conduct the operations leisurely, and at whatever place and time that may offer the best conditions for a good fermentation, is so great, that for the sake of good, uniform quality, some of the higher attributes of wines may willingly be waived by the majority of consumers. Doubtless the Springmühl process will not make "Chateau" wines, but it seems very likely to redound to "the greater good of the greater number."

TABLE 11—SUMMARY VIEW OF EXPERIMENTAL FERMENTATIONS OF CONDENSED MUST.

	ROOM TEMPERATURE, 75°.		
Number	801.	802.	802 *a*.
Mode of fermentation	Floating cover; foulage.	Floating cover; pumping air.	Floating cover; pumping air.
Time of fermentation	115 hours.	120 hours.	146 hours.
Solid contents at pressing	3.5%.	4.0%.	4.0%.
Temperature of must at setting	63°.	63°.	63°.
Maximum temperature	92.5°.	91.5°.	93°.
Hours from setting	66 hours.	66 hours.	96 hours.
Tannin (February 7, 1888)	----------	.259%.	----------
Acid at pressing	.60%.	.59%.	.60%.
Acid, July 12, 1888	----------	----------	----------
Maximum color	16.6%.	16.6%.	14.6%.
Time of extraction	73 hours.	73 hours.	79 hours.
Color, February 9, 1888	10.6%.		
June 28	8.3%.		
Total decrease from maximum to June 28	47.7%.		

ANALYSIS OF MUST AND WINE FROM CONDENSED MUST (ZINFANDEL AND BURGUNDY GRAPES). VINTAGE OF 1887.

No. 801.

Must:	Sugar by spindle	Original must	72.6
		Diluted must	24.2
	Acid	Original must	1.17
		Diluted must	.39

			Feb. 9, '88.	July 13, '88.
Wine:	Alcohol	Volume	13.00	13.00
		Weight	10.54	10.54
	Body		3.10	3.10
	Tannin		.26	------
	Acid		.49	.51
	Acid at pressing		.60	------

ANNOUNCEMENT.

INSTRUCTION IN VINIFICATION AND WINE ANALYSIS.

A course of instruction in the principles and practice of vinification and wine analysis will, as heretofore, be given at the experimental laboratory of the University of California, during the vintage season of 1888, in connection with the experimental work, and illustrated by the abundant material now supplied by the outlying viticultural stations and the contribution of private parties. The course will open September 20th.

The viticultural laboratory now forms part of the general agricultural laboratory located in the new experiment station building, and its accommodations and appliances, as well as those for cellar work, have been greatly enlarged and perfected by the aid of United States experiment station fund.

Students desiring to take this course should make their intention known as soon as possible, in order that laboratory accommodation for them may be provided in advance, and delay in beginning their work be avoided.

Applicants for this course, while not required to pass the regular admission examinations to the University, will be specially examined as to their ability to pursue the course with profit to themselves, and without interfering with the progress of the class. This requires *at least* the possession of a good grammar school education; and in addition a knowledge of at least elementary chemistry, and of some acquaintance with winery work, are extremely desirable. The more of general knowledge and experience the student may have, the better will he be able to avail himself of the opportunities offered in this course.

The exercises embrace, besides daily work in the laboratory and cellar, twice-weekly lectures by Professor Hilgard, on vinification and the chemistry of wines; also attendance upon the first portion of the general course of agricultural chemistry (thrice-weekly) by the same.

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